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The Role of Science in Our Unique Society

James B. Conant
Harvard University, Cambridge, Massachusetts

PERHAPS A WORD OF WARNING will not be out of place at the outset—a word of warning addressed to any members of this audience who are not members of the Association. To the scientist I need hardly say that, as retiring president of the American Association for the Advancement of Science, I am in no sense a spokesman for science or the scientist. Quite the contrary. The tradition in this Association, as in all other scientific gatherings, is that everyone speaks for himself and only for himself. Election to office provides a platform, sometimes a few hearers, but not always followers or believers. I open with these obvious remarks, for in large measure what I have to say may seem not only heretical but objectionable to many of my scientific colleagues. Therefore, I emphasize the tradition by which an officer of this Association may in his views represent a minority position—even as small a minority as one.

Tonight I am supporting the thesis that in the United States during the next few decades science may well play a determining role in the outcome of affairs; there is no heresy here—only a platitude, I am sure. The same statement might be made by a speaker in London, Paris, or Moscow making the appropriate national substitution for the words "the United States." Every industrialized nation is dependent on applied science for the continuing welfare of its economy and, alas, for the military security of its frontiers and cities. In my opinion, however, there is a special sense in which science is called upon to help with our national problems here in this country. Furthermore, it seems to me that a special group of sciences is involved. These are concerned with the study of man and, it may be noted, function differently in various nations, depending on the cultural pattern and the ideology; physics and chemistry are the same on both sides of the alleged iron curtain—not so, social psychology or anthropology.

What Is Science?

Before developing the basis for these dogmatic statements I must tax your patience by explaining briefly what I mean by science and why I refer to this republic of free men as a "unique society." Addressing myself once more to any in the audience who are not scientists, I must caution you that there is no agreement whatsoever as to the definition of the words science, scientists, or scientific method. Prof. H. Dingle has recently written: "When we contemplate the ideas of the essential nature of science which are most prevalent and operative today we find a situation fit to make the angels weep!" He might have added that when one uses the adjectives "pure" or "applied" in connection with science, the angels depart, for there is almost certainly a violent argument in the making.

For example, there are those who believe passionately that all rational and relatively unprejudiced inquiries are scientific. Such people often maintain that, in theory at least, there is a continuous transition between those problems which yield to the labors of the scientific investigator or the engineer on the one hand, and on the other, all the vexing questions which confront men and women in factories, offices, and political gatherings as well as in the nursery, the kitchen, and the garage. A distinguished member of this Association whom we all hold in the highest esteem has written: "Men and women effectively trained in science and *in the scientific method usually ask for the evidence,* almost automatically. They have some of the experience and more of the critical judgment necessary to evaluate the evidence." One cannot help wondering where the author of this categorical statement obtained *his evidence.* I should have supposed that only a very exhaustive study of reactions and attitudes of many people with and without scientific training of various sorts could possibly supply the data from which such a generalization could arise. As far as I am aware, no such study has as yet been made. Perhaps here is an illustration of what certain types of scientists might accomplish and thereby clarify our thinking on an important educational issue. But I am getting far ahead of my story. Let me return to this question of defining science.

I ventured to propose some years ago that the secular learned world might be conveniently trisected. Supporting myself as best I could by quoting Francis Bacon (and only slightly misrepresenting his point of view), I suggested that we would do well in this century to distinguish between (a) accumulative knowledge, (b) philosophy, and (c) poetry. The

Address of the retiring president of the AAAS, delivered on the evening of December 27, 1947, at the 114th meeting of the Association in Chicago, Illinois.

operational test to distinguish the first area from the other two is relatively simple and quite obvious. Whenever it can be said with some assurance that earlier writers or practitioners, if brought to life today, would recognize the superior position of their successors, then we can speak of accumulative knowledge. By such a test one distinguishes between Plato on the one hand and Archimedes on the other, or between Milton and Harvey, or between Immanuel Kant and Newton.

Large portions of history and philology as well as all of archaeology fall under this definition of accumulative knowledge, as do the physical and biological sciences and mathematics (including symbolic logic). Our increasing knowledge of man as an individual and as a social animal and all of the practical arts from mining through agriculture to government are likewise included, provided, of course, there has been real progress. This whole vast field may be called science if you choose; the German word "Wissenschaft" is often used in just this way.

I think, however, that this broad use of the word science is apt to be confusing. The word science has very definite connotations to laymen. These are today connected with only one branch of accumulative knowledge. Therefore, I suggest we define science historically by equating it with the extraordinary activity which arose in Italy in the 16th Century and spread to the rest of Europe in the 17th, and which in our time has flourished and proliferated with so much vigor. Around 1600 there was a change in point of view among learned men which was so marked as to be revolutionary. It was so regarded by the leaders of thought of the 17th Century, who often spoke of the "new philosophy," meaning by that, experimental and observational science.

I place science within the area of accumulative knowledge, therefore, instead of regarding it as coextensive with it. According to my view, only in very recent times did science emerge from the other human activities which had been accumulating knowledge for thousands of years (though I recognize, of course, that one traces a sort of prenatal history of science back to the Greeks and even further). The characteristic of the new philosophy of the 17th Century was that it sought to deal with those ideas or concepts which arose from controlled experiment or observation and in turn led to further experiment and observation. Science, thus defined, is to be regarded as a series of interconnected conceptual schemes which arose originally from experimentation or careful observation and were fruitful of new experiments or observations.

The test of a new concept is not only the economy and simplicity with which it can accommodate the then-known observations, but its fruitfulness. Science has a dynamic quality when viewed not as a practical undertaking but as a process of developing conceptual schemes. Science advances not by the accumulation of new facts (a process which may even conceivably retard scientific progress) but by the continuous development of new and fruitful concepts.

The definition of science I have chosen, I should like to emphasize, is entirely independent of the field of inquiry or of any application of the knowledge obtained. Parallel with the development of science in the last three centuries and a half there has been a rapid development of the practical arts. At first the two activities were largely independent in spite of the hopes of Francis Bacon and the new philosophers. Improvements in the art of working metals, of growing food, of making glass and ceramic materials, and even in increasing the destructive power of weapons, was little affected by the early scientific work. It is not until we get into the 19th Century that we begin to see anything like the practical influence of scientific progress to which the first scientists so confidently looked forward. And it is only in the 20th Century that we have seen so close an interaction between advance in science and progress in the practical arts as to result in some popular misunderstanding about the relation of the two.

Advance in Science and Progress in the Practical Arts

Since the role of science in any society today is intimately associated with the application of scientific knowledge, I am going to take the liberty of pursuing still further an inquiry into the relation of advance in science to progress in the practical arts.

It is as though we were dealing with a continuous spectrum. At one end we may place the changing conceptual schemes arising from experiment and giving rise to experiment (pure science, if you will); at the other end we place the improvements in the practical arts that have been proceeding for millennia. Not until about 1600 does the pure science end of the spectrum become visible. While this end increases in width and intensity for the next 200 years, so likewise the opposite end continues to glow brightly. Then the intervening space narrows, and in this century the intermediate zone becomes full of glowing lines connecting the once totally disparate ends with each other.

The procedures of the scientist are now used daily to solve immediate problems which were once solely within the province of the skilled artisan. Though we can still recognize the two ends of the spectrum to which I referred, the intermediary zone now occupies the main position. For not only has "pure" science invaded the practical arts, but the practical arts have penetrated deeply into science. In many areas one

cannot distinguish between the "techniques" of the scientist interested only in new conceptual schemes and those of the experimenter interested only in an improved industrial machine or process.

If we turn our attention from the physical sciences to the biological, we find a similar phenomenon. How difficult it is today to draw the line between pure and applied science in such fields as biochemistry, physiology, and even bacteriology! The application of new ideas and new tools developed by the physicist and chemist to the study of biological problems has been one of the most successful undertakings of the last three decades. Is this "pure" science or "applied" science? Who can say? Within each subdivision of the subject matter one can recognize a whole spectrum of activities ranging from the search for a broad understanding of certain biological processes to immediate concern with a very specific case. Certainly, the interplay between investigators pressing for solution of medical and agricultural problems and those concerned only with fundamental studies is today very fruitful. There is no room for argument as to which is a superior activity. Neither the clinician nor the chemist can afford to look down his nose at the other fellow. They are too busy cooperating, one with the other.

This was not always so. In the middle decades of the 19th Century, the cleavage between scientists and practitioners was much greater than in our time. This was so both in the physical and biological sciences. Clerk Maxwell's public comments on Alexander Graham Bell's telephone is a case in point. The physicist reviewing the inventor's work left no doubt in the audience's mind who was top dog in any hierarchy that mattered. Even Pasteur could be regarded by his contemporaries as a promising young chemist gone astray. Like Humphry Davy before him, he was working for the doctors; but, unlike Davy, he came into this sad occupation not as a piece of youthful folly but as a mature man. (But unlike Davy's experience in Dr. Beddoes' pneumatic institute, Pasteur's mixture of chemistry and biology in the 1870s proved fruitful for that branch of applied biology which is concerned with diseases of animals, including man.)

The pendulum has now swung very far to the other side—too far, some scientists would say. Today investigations concerned with disease rather than with basic concepts in biology are apt to receive popular acclaim and, what is more important, large financial backing. The applications of physics and chemistry fill the newspapers and to a surprising degree even the scientific journals. Is there danger that in the present fusion of pure and applied science the tradition of the investigator interested *only* in the conceptual schemes will be so weakened as to disappear? I am inclined to think so. If this happens in any country, the effectiveness of the application of the physical and biological sciences to practical problems will soon diminish greatly. For the history of the last half century shows that only by a continuous development of the pure science end of the spectrum (to continue the metaphor) can the practical arts, including medicine, advance at their present speed.

The Degree of Empiricism in a Given Science

To my mind we need to analyze the present situation, not by attempting to classify the various sciences and their subdivisions into pure and applied science, but by examining closely each separate undertaking. I have suggested in a paper on "Science and the Practical Arts" that we need to inquire as to the degree of empiricism now present in any branch of science. The cases I quoted as examples were classical optics and chemotherapy. In the former the conceptual scheme employed has wide validity, the degree of empiricism is very low. In the latter the concepts are few and of limited application, progress toward a new drug is still very much of a "cut and try" affair, the degree of empiricism is high. Practical consequences of considerable importance flow from such an analysis of the various sections of different sciences. But it is not with these consequences that I wish to deal here. Rather, I should like to suggest that unless progress is made in reducing the degree of empiricism in any area, the rate of advance of the practical arts connected with that area will be relatively slow and highly capricious. Thus, in terms of new machines, new weapons, new drugs, new ways of improving public health, studies designed solely to provide a better understanding of the fundamentals are thoroughly worth while.

Therefore, rather than debate endlessly about pure and applied science, we might do well to emphasize the need for more satisfactory and wider conceptual schemes in almost every field. Recognizing that some practical problems cannot wait on the outcome of efforts to lower the degree of empiricism of the science in question, nonetheless we can hope that not too large a share of scientific effort will be directed to immediate ends. The history of science shows, I believe, that at times a wider understanding has come about by the piling up of new but limited concepts, each representing but a slight advance, yet, when taken together over several decades, making a highly significant improvement in the scheme. Sometimes these new developments have been intimately associated with the solution of practical problems. (Pasteur's work is the example which comes to mind.) At other times this approach has been relatively unsuccessful, and only by considering the problems in splendid isolation from any practi-

cal considerations were the new concepts evolved which later proved to be of enormous practical significance.

The Importance of Fundamental Research

If one looks at the whole range of industry from the manufacturing plant through the development group to the research laboratory from this point of view, the long-range significance of certain types of endeavors becomes clear. If one looks at agriculture, medicine, or public health in the same way, the importance of reducing the degree of empiricism in almost every field of science becomes manifest. Therefore, a society interested in machines, new materials, better foods, and greater health—in short, an increasing standard of material welfare—will devote a considerable share of its intellectual manpower to long-range as well as short-range scientific programs.

If I were addressing an audience of nonscientists, at this point I would insert a paragraph or two in order to underline an obvious point. The kind of work which leads to the development of new conceptual schemes (pure science, if you will) is almost impossible to plan. One might put it this way: short-range programs in science can be planned and assessed in terms of the calculated risk. Long-range programs, by their very nature, represent much greater gambles, but the consequences of success are correspondingly great. This is the field, therefore, for the individual worker or the small team who are neither expected to show results nor confined to a plan of action specified in advance. In short, this is why we need professors of science of the highest caliber in our universities, and why these men should be well supplied with funds. To argue further on this subject here, however, would be to force the proverbial open door.

Special Needs of Our Unique Society

It is long past the time when I should revert to the subject of this address, namely, "The Role of Science in Our Unique Society." Up to this point I have indicated how significant was science for *any* modern industrialized nation. I have likewise pointed out how closely interwoven is progress in science, regarded as a purely intellectual undertaking and advance in the practical arts including medicine. Now I should like to consider the special situation of the United States.

According to my view, the society that has been developed in this country is unique. It is similar to other democracies in many respects, but because of our special history we have certain ideals that are a product of our past. Our solidarity as a nation depends on our acceptance of these ideals and a concerted effort to move continuously toward the social goals implied. This is no easy matter, however. The complexities of modern society are great. For the future welfare of this society, we require, therefore, the services of a group of able scientists whose numbers now are few. These men, in turn, need to have developed very rapidly new tools and new concepts, for at present the degree of empiricism in their endeavors is far too high. Unfortunately, the group of sciences I have in mind, unlike physics or chemistry or the classical aspects of biology, have no long record of success behind them viewed either as a dynamic development of conceptual schemes or as aids to practical-minded men. Nonetheless, I am convinced that this is the strategic time to stimulate and encourage these endeavors. Specifically, certain types of work in sociology, anthropology, and social psychology seem full of promise. The point of view of the younger men in these fields (and I emphasize the adjective younger) indicates that the time is now at hand when rapid advances will be forthcoming, and from these advances will flow practical consequences of great value to this Nation.

It would seem obvious that the best minds of the country should be devoted to a study of the many problems arising as a consequence of our endeavors to keep our society prosperous, strong, and democratic. It is my belief that methods have already been developed to a point where studies of society by competent scholars can provide basic information to assist all those practical men who struggle with the group of problems we list under the head of human relations. Both fundamental investigations as to the nature of man and society and immediate studies of specific problems are required. The cooperation between medical men and psychologists should be strengthened. Whether psychiatry is to be classed as a subdivision of psychology or of the medical sciences is of little consequence; in emphasizing the importance of the sciences of psychology, anthropology, and sociology here tonight, I am using these designations in the widest sense. I assume that the newer approaches to many of man's individual emotional problems will involve the physiological as well as the psychological approach.

The Future of the Sciences of Man and Society

My confidence in what may be accomplished flows from my assumption that advances in the science of man and society will go hand in hand with fruitful applications of the present techniques and concepts. Relatively few people realize how much progress has been made in the last decade and what techniques are now available to assist in the solution of practical problems. But it is the future which is exciting, for I imagine that even the most enthusiastic psychologist or anthropologist would readily admit that at the present moment the conceptual schemes at his disposal are the equivalent of what chemists and physicists had

in the late 18th Century. As a consequence, in every case of the practical application of the sciences concerned with human behavior, the degree of empiricism is very high.

As in the medical sciences in recent years, many of the practitioners should be the very ones to advance the science. If a chemist may be bold enough to give advice to younger colleagues in a far-distant field, I would say the life of Pasteur affords a relevant analogy. As a scientist and as a practitioner, he solved immediate problems and likewise reduced the degree of empiricism in those branches of biology he made his own. Do not be misled by the divorce of theory and practice which characterized the work of Newton, Clerk Maxwell, and even Darwin. There are times and places when even the purest science cannot make progress in the ivory tower. On the other hand, one may express the hope that the ultimate consumer, the general public and the practical men, will not press too strongly for immediate results. Projects concerned with applying the knowledge now at hand must not be so numerous or exacting as to prevent a sturdy effort to decrease the degree of empiricism in the methods now in use. In short, the long-range as well as the short-range programs require adequate support.

Value Judgments as Premises in Certain Sciences

The statement is often made that science is neutral as far as value judgments are concerned. This is one of those three-quarter truths fully as dangerous as half truths. Let us consider the medical sciences today. Investigators and practitioners concerned with human disease almost unconsciously accept a set of values which set limits to their activity on the one hand and on the other serve as powerful spurs to their endeavors. This fact seems to be overlooked when the neutrality of science is proclaimed. Much more than the Hippocratic oath is involved. Only in a society where life is considered preferable to death and where health is glorified would funds flow freely for the study of disease. Only where the sanctity of each individual is so strongly felt that it is regarded as a paramount duty to save every life possible at whatever cost would physicians, surgeons, and medical scientists act as they do today. Our standard of medical care and our desire to raise it is based on a series of value judgments. Let me make it plain—I am not questioning the assumptions. I am merely pointing to the existence of these postulates basic to all work in the medical sciences. I do so, for I believe the situation is analogous in the case of those scientists who are investigating human behavior and human relations; but the analogy has not yet been fully realized.

The assumptions of the medical men and their allies are by now fairly well accepted in modern industrialized nations, though in practice the value placed on human life certainly is subject to wide variations. The assumptions essential for the proper functioning of the psychologist, anthropologist, and sociologist in our unique society, however, are, I believe, as special as the history of this society itself. The equivalent of the Hippocratic oath which these men might well subscribe to would therefore be related closely to the type of society in which they propose to operate. The English and the American versions even might vary at several points, but the essentials would be the same. Totalitarian nations, however, would use the techniques developed by these scientists for very different ends; and their use would condition the further advancement of the sciences themselves. Powerful tools are in the process of being forged by the scientists who study man as a social animal. These tools can be used to further or to destroy certain types of behavior and certain social patterns. Therefore, it is essential for the men themselves to clarify in their own minds their own standards of value in many matters, just as, long ago, the medical profession settled certain issues which confront those whose knowledge includes the key to the life or death of an individual in distress.

Making the Bias Explicit

A study of the writings of the last 50 years makes it evident that the myth of the neutrality of science has been used as a smoke screen for reactionaries and radicals alike. For example, within recent times some who wished to see a tight class structure develop in the United States have analyzed society in so-called scientific terms. Likewise, those who wished for a socialistic state can quote the results of modern investigators of society for their own ends. My objection to these procedures stems less from my lack of enthusiasm for the objectives than from the failure of the authors to be explicit as to their premises. Gunnar Myrdal has faced this question squarely and said: "There is no other device for excluding biases in social science than to face the valuations and to introduce them as explicitly stated, specific and sufficiently concretized value premises."

I am inclined to think that, to forward their own work as scientists and practitioners, those concerned with the sciences of man might well join together and issue a proclamation. Or if that is too much to hope for, recognizing the importance of rugged independence among learned men, at least as individuals, each one might make his position clear. Of course, it is for the men in question to formulate their own Hippocratic oath; nevertheless, to illustrate what I have in mind, I venture certain suggestions.

The Postulates of Our Unique Society

I believe a very large majority of the citizens of this country would be willing to subscribe to a common set of postulates as to what we desire to accomplish in the coming years. The goals of equality of opportunity, a minimum of class distinction, a maximum degree of individual freedom, and a wide distribution of centers of initiative are inherent in the American tradition. Would not all of us be happy if we felt certain that a decade hence the United States would be appreciably nearer those historic goals? So it seems to me. Therefore, the set of social ideals corresponding to these goals might form the basis of agreement among the scientists in question. All concerned with medical science, however objective and neutral they may claim to be, are urged forward with a desire to improve the public health and a firm conviction they will do so. Likewise, the scientist concerned with human relations and the structure of society must have conviction as to the practical objectives of the practitioners in his field and a belief in the possibility of accomplishing at least some of the objectives they have in mind.

I have drawn a parallel between the application of modern science to the ancient art of healing and the application of certain sciences (still young) to the likewise ancient art of counseling human beings as to how to live and work together. If there be any merit in my analogy, the reason why I spoke at the outset of basic differences in these sciences between totalitarian countries and our own needs no elaboration. Biochemists, physiologists, and pharmacologists would be either out of place or enlisted in strange services in a society which regarded it essential to eliminate by death all infants except the physically robust, all the sick and wounded, and all above 60. (The comparison, to my mind, is far from being entirely fantastic.)

Without laboring the difference between the study of man and society here or, let us say, in Rumania, I should like to explain in more detail why I think our unique society has special need at this moment for the scientists in question.

The Problems Ahead

The United States, unlike almost any other country, has not arisen from a state founded on military conquest. Therefore, we have nowhere in our tradition the notion of an aristocracy entitled to rule by right of birth. Run through the other democratic nations of the world and, if you recall their history, you will see how striking is our exceptional origin and growth. Neither political nor economic nor social privilege comes to one by right of birth according to our American ideals. On the contrary, the members of each new generation are supposed to start from scratch. Merit alone should win. Cynics may shrug their shoulders and say this is theory—the facts of modern American life are far different, and likely always to remain so.

We must admit that sneers of this sort expressed by men who pride themselves on being hard-boiled realists are sometimes heard. Those who express such ideas fail to realize that in an open society ideals are goals. Almost by definition they never can be realized in practice. But we can recognize whether we are moving toward them or retreating. The ideal of equality sums up much of the uniqueness of American society to which I have referred already. This ideal, coupled with our adherence to the principles embodied in the Bill of Rights and our inherent belief in fair play and tolerance, makes a pattern which many of us have in mind when we use such phrases as "the American creed." In spite of the vast discrepancy between those ideals and the facts of life, I am convinced that we are not a nation of hypocrites. But unless we can demonstrate by collective action that we are making progress toward the goals implicit in our ideological pattern, we shall have difficulty maintaining the solidarity of the country. The morale of a nation, no less than that of any group of men or women, depends on agreement as to the ends for which all labor.

It is no simple matter to move appreciably toward the goals in question—the historic goals of our unique society. Industrialization as well as size present us with problems of terrifying complexity, not to mention the unfavorable posture of world affairs. Our economy is based on private ownership and the profit motive; we desire to keep this economy flexible with as many competing units as modern industrialization permits, and with as much independence for both management and labor. Yet there are few who advocate today the old doctrine of "hands off" private enterprise. The complexities of modern society have made the public a party to what once seemed a strictly private matter. The machinery of government is today meshed into our industrial life. The problem is to see how we can operate our private enterprises and our political institutions so that our society will be in fact competitive and thereby increasingly productive.

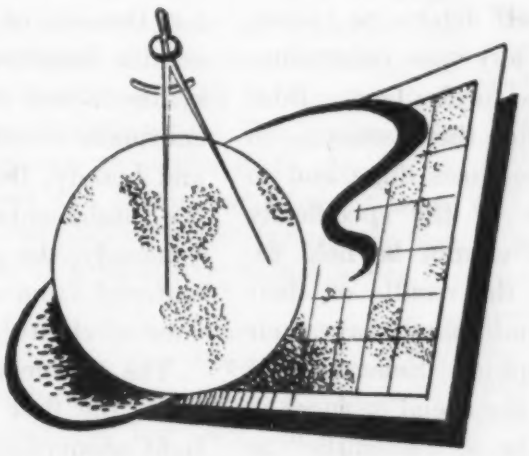
Grave problems of fundamental policy confront us as a nation at this moment; they will continue through the coming years. I have no illusion that basic national issues can be handled by any group of scientists in the way problems of design of bridges and machines can be treated by engineers. Nor do I believe that in the near future many policy questions which must be resolved by governmental officials, business executives, or labor leaders can be handed over to scientists to find an answer which is "right." Most of the decisions must be made on the basis of experience coupled with the advice of competent analysts and those whom I

have ventured to call social philosophers. The point of view of scientists may be of assistance in these matters, and the results of their investigations should be of increasing value. But the types of problems where one can hope for immediate assistance from the social psychologist, sociologist, and anthropologist are for the most part somewhat limited in their scope; they involve human relations and those tensions among individuals and groups which have been so much intensified by the conditions of modern life.

The need for reducing these tensions as part of the process of improving and humanizing industry is evident. What is less well understood is the applicability of the newer points of view to the planning of public education and providing that our secondary schools will serve the welfare of the community. In short, policy makers in government, business, labor, and education must be increasingly aware of the assistance they can receive from those who study man and society as scientists.

Let me illustrate by a brief consideration of our public schools; they are a concrete manifestation of our belief in the idea of equality of opportunity. We believe they should be ladders by which youths with varied talents may reach satisfying employment with everyone entitled to a fair chance. Every year some two or three million of our youth mature, leave school or college, and look for jobs. Unless each year this annual crop of youngsters can be fitted into our economy, we shall fail to keep our society prosperous and dynamic. Therefore, our educational system must be heavily involved in the whole question of guidance and of placement. The specific problems will vary from city to city, from state to state. Here is a case where we are beginning to have sound knowledge and can look forward with considerable assurance to further improvements in the methods. Here is a case where the welfare of the Nation depends on our skill in solving a whole host of detailed human problems.

I could go on and list similar instances concerned with education, group relations, social organization, and personal adjustment to show how in our society we have special need for a vastly improved science of man. The empiricism of the past may be a sufficient guide for the masters of a police state, but an open society with our ideals requires other instruments and a wider understanding of modern man. We would be wise to expect no miracles and not to harass ourselves or the scientists by shrill cries for speed. My crystal ball yields me no secrets as to the future of the world. Conceivably, we may all be blown up by atomic bombs within the next few years, as some of my colleagues seem to think. Their reasons for this dire prediction, however, appear to me to be quite inadequate. I prefer the contrary assumption. I have faith that we shall be wise enough to escape a global war. I likewise believe that we shall move forward to still greater strength and prosperity as a democracy, and that the morale of the Nation will continually improve as we demonstrate that our American ideals are no mere myths or legends. And in this all-important undertaking, I have confidence that the skill and wisdom of the scientists cooperating with practitioners will play an important part. Those who concur in some such estimate of the potentialities of this country will surely agree with me that science will play a leading role in the future of our unique society of free men.



Association Affairs

Section on Education (Q)

At the recent AAAS meeting in Chicago Section Q held three meetings and a joint meeting with Section I, at which the vice-presidential addresses of the two sections were given. In his vice-presidential address for Section Q, W. A. Brownell discussed three criteria of especial importance in educational research. He pointed out that these apply especially to educational research and might, or might not, be equally pertinent to psychological research. The criteria which he mentioned were: the level of process attained as distinguished from mere measures of product, the degree of retention of learning, and transfer-ability. He noted that too few studies of learning or of remedial practices have been followed up by investigations at later times to see if the changes produced have persisted. Evidence was given, also, to show that, when measured by the criteria of transfer-ability, some methods were found to be superior which were not superior when measured in terms of speed and accuracy of performance only.

A very stimulating symposium on "The Place of Science and Philosophy in Education" included papers by an educational scientist, an educational philosopher, an academic scientist, and an academic philosopher. Educational methods were at first derived from philosophy rather than science; later, in many areas, scientific methods were used to determine what should be taught and how it should be presented. Now there seems to be, again, a definite tendency toward philosophical methods. While it was recognized that science does not in itself determine values, it was strongly emphasized that any wise determination of values is based upon scientific fact. Educationists were called upon to define their terms much more exactly than they have sometimes done and to evaluate their findings in terms of the specifically defined ends desired. Scientists cannot be held responsible for the uses to which the results of their studies are put, but scientists as individuals have their place in influencing social philosophies. Sciences vary in their degree of maturity, and the social sciences in particular cannot yet claim to be as "scientific" as some of the older disciplines. Various misunderstandings and misconceptions in regard to scientific method were set forth as answers.

Another symposium was on "The Relationships of Group and Individual Research in a World of Large-Scale Organization." The impossibility of adequately solving some of our problems in terms of the work of individuals or in terms of work done at single locations was brought out. Several examples of successful group research were described. At the same time, it was emphasized that no research workers have yet had experience in group research and that group studies, then, must be undertaken rather gradually. Further, it was made clear that individual creativeness must not be lost.

A final meeting was held in which major emphasis was placed on the status of achievement in school subjects, primarily reading and spelling—present school children as compared with those of earlier times. Difficulties of making good comparisons because of changes in curriculum contained in the desired objectives, in the nature of populations, in school studies, etc. were mentioned. Some evidence was presented, however, to indicate that, especially in the field of reading, children of the present day are distinctly ahead of those of a couple of decades ago. (D. A. WORCESTER, *Secretary.*)

Symposium on Photosynthesis (Section C)

Eighteen papers were presented in a day-and-a-half symposium on photosynthesis, the first to be held for the past 5 years. There was considerable discussion of the various papers and a general conference at the close of the sessions. The attendance, ranging from 100 to 400, comprised mostly chemists, botanists, and biologists.

In opening the symposium, the chairman, Farrington Daniels, of the University of Wisconsin, pointed out the long-range importance of the study of photosynthesis and stated that it is strange, in view of the enormous amount of research invested in agriculture and botany, that so little attention has been paid to the fundamental reaction underlying all plant growth —namely, the production of carbohydrates and other material from carbon dioxide and water in the presence of chlorophyll and sunlight.

The problem was attacked along several different lines, the first half-day being devoted to studies of light absorption by chlorophyll and other plant pigments, the emission of fluorescent light, and measurements of photochemical oxidation-reduction reactions carried out in the laboratory, designed to gain a better understanding of the photosynthetic reaction in the plant.

The important advances being made with radioactive carbon as an isotopic tracer were described during the second half-day session. These experiments show that carbon dioxide is taken up not only in the light but also in the dark. Intensive efforts with carbon 14 as a radioactive tracer are being directed toward determining the composition of the first photosynthetic product. It appears to be a substance containing both carboxyl and hydroxyl groups which is soluble in hot alcohol and insoluble in benzene. Possible mechanisms were discussed, including reaction cycles by means of which the radioactive carbon is distributed among various organic acids and products.

The energy efficiency with which the light is used in photosynthesis was discussed on the third half-day. Warburg's manometric technique leading to a quantum efficiency of 0.25 molecule of CO_2 consumed per quantum of light absorbed was criticized, and yields of about 0.1 molecule per quantum were described. Different measurements based on manometric technique, on calorimetry, on the dropping mercury electrode for oxygen analysis, and on the platinum electrode for oxygen analysis were carried out independently in different laboratories, and all gave quantum efficiencies in the neighborhood of 0.1 molecule per quantum.

The impression was gained that rapid progress in our understanding of the mechanism of photosynthesis will now be made along the lines discussed at the symposium. (FARRINGTON DANIELS, *Vice-President.*)

NEWS and Notes

Presentation of the 1947 AAAS-George Westinghouse Science Writing Awards was made at a dinner on December 27 during the meetings of the AAAS in Chicago. The two $1,000 awards were made to George Keaney, staff writer on the *New York World-Telegram*, in the newspaper division, and to Steven M. Spencer, associate editor of the *Saturday Evening Post*, in the magazine division. Honorable mention in the magazine writing contest was given jointly to Lorus J. and Margery J. Milne for their article in the June 1947 issue of *Natural History*. (See *Science*, November 28, 1947, p. 513.) Citations were also presented to the publications in which the winning entries appeared. Pictured on this week's cover are those who participated in the ceremonies: *left to right*, Lee B. Wood, executive editor of the *New York World-Telegram*, also representing Mr. Keaney, who was unable to attend; Mr. Spencer; Harlow Shapley, toastmaster; Mrs. and Mr. Milne, who also received the citation in behalf of *Natural History;* and Robert Fuoss, managing editor of the *Saturday Evening Post*.

Guest speaker at the dinner was George D. Stoddard, president of the University of Illinois. His subject was "Science Aids Civilization."

About People

Robert E. Marshak, associate professor of physics, University of Rochester, and chairman of the Federation of American Scientists, has been appointed a member of the School of Mathematics, Institute for Advanced Study, Princeton, New Jersey, for the spring semester. Dr. Marshak will be in residence at the Institute from February 15 to April 15.

J. Russell Bright, associate professor of chemistry, Wayne University, has been made acting chairman, Department of Chemistry, following the resignation of **Neil E. Gordon** from the chairmanship. Dr. Gordon will continue as professor in the department and as director of the Kresge-Hooker Scientific Library and the University's chemistry lecture series.

William R. Grove, professor of psychology and director, Division of Psychological Services, University of Pittsburgh, has been appointed psychologist and director, Child Service Study, Phoenix Public Schools. **Carroll A. Whitmer**, formerly with the Pittsburgh Public Schools, will succeed Dr. Grove at the University of Pittsburgh.

Alfred Washington Drinkard, Jr., director, Virginia Agricultural Experiment Station for 30 years, and assistant director for the past year, will retire February 1.

Jack Matthews, formerly of Purdue University, has been appointed director, Speech and Hearing Clinic, Departments of Psychology and Speech, University of Pittsburgh.

H. B. Mann, of Atlanta, Georgia, formerly Southern manager of the American Potash Institute, has been appointed vice-president of the Institute. Dr. Mann assumed his new duties January 1 at the Institute's headquarters, 1155 16th Street, N. W., Washington, D. C.

William G. Pollard, acting executive director, Oak Ridge Institute of Nuclear Studies, since February, 1947, and formerly professor of physics, University of Tennessee, has been made executive director of the Institute.

Marston Taylor Bogert, professor emeritus of chemistry, Columbia University, and former president, American Chemical Society, has been appointed senior scientific adviser, Evans Research and Development Corporation.

John C. Crowell, who recently received the Ph.D. degree in geology from the University of California, Los Angeles, has been appointed instructor in geology at that University.

R. Ruggles Gates, emeritus professor of botany, University of London, and research fellow in biology, Harvard University, has recently lectured at various Midwestern universities on the evolution of man, human genetics, and the nature of species. The universities visited include Iowa State College, State University of Iowa, University of Illinois, University of Minnesota, University of Wisconsin, and Michigan State College.

William Haber has been appointed chairman, Division of Social Sciences, University of Michigan, for a three-year term (1947–1950), succeeding **James K. Pollock,** whose term has expired.

Hans Molitor, director, Merck Institute for Therapeutic Research, who is making a trip through Central America to study Indian and Mayan drugs, will make a report to the University of Texas Medical Branch near the end of this month, and on January 26 will give a special lecture on "The Pharmacology of Antibiotics" at the Medical Branch.

Joseph B. Koepfli, chemist, California Institute of Technology, has been appointed a member of the Mission on Science and Technology to England, which is headed by Earl A. Evans, Jr., chairman, Department of Biochemistry, University of Chicago (*Science*, November 28, p. 518). Dr. Koepfli will be attached to the U. S. Embassy in London as a senior scientist for a period of one year.

Jerry W. Carter, Jr., director, Wichita Guidance Center, Wichita, Kansas, has been appointed to the position of scientist (R), U. S. Public Health Service, and will be assigned around February 1 to the Mental Hygiene Division, Washington, D. C. **Joseph E. Brewer,** assistant director, Wichita Guidance Center, has been made acting director.

David B. Tyler joined the staff of the Department of Embryology, Carnegie Institution of Washington, Wolfe and Madison Streets, Baltimore, Maryland, on December 1.

Jacob Rappaport, recently assistant professor of plant physiology, University of Ghent, Belgium, has been appointed plant physiologist at the Smith College Genetics Experiment Station. He will aid in research on the physiological aspects of ovular tumors, being supported by a grant from the American Cancer Society.

Arthur C. Bates, formerly of Bell Telephone Laboratories and the Studebaker Corporation of America, has been appointed professor, Department of Mechanical Engineering, Lehigh University.

Colleges and Universities

Eight Cornell University graduate students will soon begin a nation-wide survey of current methods of conservation education and science teaching, under the direction of E. Laurence Palmer, professor of science and nature education at Cornell. A representative of the group will visit every state to gather data from elementary and high schools, junior colleges, outdoor laboratories, wildlife sanctuaries, and national parks. This study, which is expected to be completed by the end of 1948, and which is intended to uncover the best practices of conservation and science teaching in the country, is a continuation of similar surveys which have been conducted by Dr. Palmer since 1925 with the support of the American Nature Association and the Wildlife Management Institute. Dr. Palmer indicated that the group is seeking the cooperation of individuals or groups interested in the project, and would welcome information and suggestions for aiding the study.

The Postgraduate Division, University of Texas Medical Branch, under the direction of T. G. Blocker, Jr., announces that a basic science course for general practitioners and physicians desiring refresher work in the basic sciences will be held in Galveston the week of February 23–28, 1948. The course will cover recent advances in the preclinical sciences. Special speakers will include John Lawrence, professor of medicine, University of California Medical Center, San Francisco; Stuart Mudd, professor of bacteriology, University of Pennsylvania Medical School, Philadelphia; Carl Moore, professor of medicine, Washington University Medical School, St. Louis; George W. McCoy, professor emeritus of preventive medicine, Louisiana State University Medical School, New Orleans; former Surgeon General (USPHS) Henry Winans, clinical professor of medicine, Southwestern Medical School, Dallas; M. S. Levy, Houston; and W. W. Powell, of Temple. A special feature of the course, which is to be under the direction of Donald Duncan, professor of anatomy, University of Texas Medical Branch, will be discussions relating to the clinical uses of radioactive isotopes.

The Division also announces a post-graduate course in physical medicine and rehabilitation to be held March 1–5 under the direction of Wilbur Selle, professor of physiology and director of the Laboratory of Medical Physics. This course is designed for the general practitioner and specialist interested in the more effective use of physical medicine. Speakers will include Frank H. Krusen, director of physical medicine, Mayo Clinic, and chairman of the Baruch Committee for Physical Medicine; Richard Kovacs, New York Polyclinic Medical School, New York; Robert L. Bennett, Georgia Warm Springs Foundation; Donald A. Covalt, New York University; John H. Kuitert, Fitzsimons General Hospital, Denver; A. B. C. Knudsen, Veterans Administration, Washington, D. C.; and Henry D. Bouman, University of Wisconsin Medical School, Madison.

The Illustration Studios of the Chicago Professional Colleges, University of Illinois, have planned a non-technical, scientific cancer exhibit for educating the general public. The exhibit will be completely installed at the Museum of Science and Industry in Chicago in about two years and will occupy a space there approximately 60 feet by 40 feet. The exhibit is being developed at the request of the American Cancer Society to aid in furthering its growing public education program. The display will cover a description of cancer, its causes, misconceptions regarding it, methods by which it spreads, methods of treatment, early diagnosis, cancer research, and

current events regarding cancer. A feature of the exhibit will be the inclusion of an information center where current information will be made available, and where discussion groups can meet and films be shown.

Industrial Laboratories

Ernest F. W. Alexanderson, consulting engineer, General Engineering and Consulting Laboratory, General Electric Company, retired January 1 after 45 years of service. Dr. Alexanderson, inventor of the alternator (a high-frequency machine operating at high speeds for continuous wave transmission at high power), was honored with a testimonial dinner at which David C. Prince, vice-president in charge of the General Engineering and Consulting Laboratory, was toastmaster.

Five Bausch & Lomb Science Scholarships of $1,500 each are again offered for the fifth year to outstanding high school and preparatory students throughout the country. April 1 is the final date for application for the 1948 scholarships. The finalists will be guests of the Bausch & Lomb Optical Company and the University of Rochester in the spring, when they will be given final tests and interviews to determine the winners. Each winner is expected to follow an undergraduate course with major emphasis on one or more sciences, according to an individual program submitted by the student and approved by the University of Rochester's Scholarship Committee.

David H. Dawson, director of sales, Pigments Department, Du Pont Company, was awarded the honorary degree of Doctor of Engineering by Drexel Institute of Technology at its Founder's Day convocation in December.

The $500 Schering Award for 1947 went to Paul J. Kopsch, Richmond Hill, Long Island, New York, a senior medical student, Long Island College of Medicine, for his paper on "The Clinical Use of Androgens in the Female." Second prize of $300 went to Robert C. Foreman, Western Reserve Medical School, Cleveland, Ohio, while the third prize of $200 was awarded to Bernard L. Rosenberg, a recent graduate of Georgetown University Medical School, Washington, D. C. The awards are presented annually by the Schering Corporation, Bloomfield and Union, New Jersey, for the best manuscripts prepared on a designated phase of endocrinology.

Meetings

E. V. L. Brown, Rush clinical professor emeritus of ophthalmology, University of Illinois College of Medicine, will speak on "Edward L. Holmes: Pioneer Chicago Eye Doctor" at a joint meeting of the Institute of Medicine of Chicago, the Chicago Ophthalmological Society, and the Society of Medical History of Chicago at the Palmer House on Friday evening, January 30. The lecture is the first presentation under the gift of the Rudolph Wieser Holmes and Maria Baxter Holmes Fund in memorial to Edward Lorenzo Holmes.

The Optical Society of America will hold its winter meeting at the Hotel Pennsylvania, New York City, March 4–6. Members wishing to present papers should submit their abstracts, limited to 200 words, on the required form by noon, February 2. Members will receive the printed program after February 21. The meetings will be open to all interested persons. Nonmembers desiring programs may secure copies from Arthur C. Hardy, secretary of the Society, who is located at Massachusetts Institute of Technology.

The American Society for X-Ray and Electron Diffraction and the **Crystallographic Society of America** will hold their first joint meeting at Yale University, April 1–3. Joint and separate technical sessions will be held, and the president of the Crystallographic Society will deliver a retiring address. Nonmembers wishing further information may obtain it from Elizabeth A. Wood, Secretary, American Society for X-Ray and Electron Diffraction, Bell Telephone Laboratories, Murray Hill, New Jersey, or from William Parrish, Secretary, Crystallographic Society of America, Philips Laboratories, Inc., Irvington-on-Hudson, New York.

The Syphilis Study Section, National Institute of Health, a group of consultants organized for the purpose of promoting research in the field of venereal diseases, announces a symposium on "Recent Advances in the Study of Venereal Diseases," to be held in the Commerce Building, Washington, D. C., on April 8–9. All interested persons are invited to attend. Copies of the program will be sent at a later date upon request. Inquiries should be addressed to Dr. Frank W. Reynolds, Executive Assistant, Syphilis Study Section, Division of Research Grants and Fellowships, National Institute of Health, Bethesda 14, Maryland.

A Symposium on Medical Subject Headings was held in Washington, D. C., on December 12–13, 1947, under the auspices of the Army Medical Library. The symposium was built about two objectives: to explore the approaches used by medical indexers and medical librarians to the related problems of printed bibliographies and card catalogs, and to determine principles which might be acceptable to both groups in their selection of new medical terminology for bibliographic purposes.

The participating members included Magdalene Freyder, American Medical Association; Murrell C. Wellman, American Dental Association; Eileen R. Cunningham, Medical Library Association; Estelle Brodman, Columbia University Medical Library; Claudius F. Mayer, Army Medical Library; Irene M. Strieby, Lilly Research Laboratories; Janet Doe, New York Academy of Medicine; Sanford V. Larkey, Welch Medical Library; D. J. Haykin, Mortimer Taube, Sarah G. Mayer, C. W. Gull, Morris C. Leikind, and Leo E. La Montagne, Library of Congress; Mabel McLaughlin and Miriam M. Wilson, Veterans Administration; Helen W. Kaan, D. L. Ballard, and Michael J. Filippi, National Research Council; Ruth Griffin and Ruth E. Rodier, Naval Medical Center; Clara Manson, College of Physicians of Philadelphia; Mary Louise Beitzell, Social Security Administration; Doro-

thy M. Cramer, National Institute of Health; Thelma B. Dunn, National Cancer Institute; Margaret C. Schindler, Department of Agriculture; Wyllis E. Wright, Williams College; and representatives of the Army Medical Library.

Following the presentation of papers, participants discussed (1) the problem of adapting medical subject headings to changing nomenclature, *i.e.* new terms used in international medical literature, particularly subject headings used for periodical literature; (2) the lack of a standard list of subject headings for the medical sciences; and (3) direct or indirect headings, involving the extent of alphabetical classification desirable in a list of subject headings. As a result of the discussion a resolution was passed which urged the creation of a standard list of subject headings. During discussion of the third problem, several of those present suggested reconsideration of classed catalogs. The general principle of direct (non-classified) headings, as well as that of specificity, was reaffirmed.

At the conclusion of the session a list of principles to be used in the selection of subject headings for medical literature was adopted.

The Philosophical Society of Washington (D.C.) held its 1293rd meeting in the Cosmos Club Auditorium January 17. The retiring president, Fred L. Mohler, delivered an address on "Mass Spectra of Hydrocarbons."

Elections

The Texas Academy of Science met in Austin, December 11–13, to discuss the conservation of natural resources. The presidential address, on "The Conservation of Man and His Resources," was given by John G. Sinclair. Chauncey D. Leake, University of Texas Medical Branch, spoke on "The History and Function of Academies." Ninety-six papers were presented in the various sections. An additional 18 were presented at the Collegiate Academy program and 24 at the Junior Academy. L. W. Blau, Humble Oil Company, Houston, is the new president, and Gladys H. Baird, Huntsville, Texas, is secretary-treasurer. It was proposed that during 1948 a State Conservation Council be established, composed of leaders in the various fields.

The Association of American Geographers, at its 44th annual meeting in Charlottesville, Virginia, December 29–31, elected the following officers for 1948: Richard Joel Russell, Louisiana State University, president; Clifford M. Zierer, University of California, Los Angeles, vice-president; John Kerr Rose, Library of Congress, councilor for three years; Charles B. Hitchcock, American Geographical Society of New York, treasurer; and Chauncy D. Harris, University of Chicago, secretary. At the annual banquet, Charles F. Brooks, Blue Hill Meteorological Observatory, delivered the presidential address on "Climatic Record: Its Content, Limitations, and Geographic Value."

The American Society of Protozoologists was organized in Chicago on December 29, 1947, during the meetings of the AAAS. At a meeting of interested protozoologists L. E. Noland, of the Zoology Department, University of Wisconsin, was elected temporary chairman. A constitution was adopted for temporary use, and the following officers were elected: Ross F. Nigrelli, New York Aquarium, president; Banner Bill Morgan, College of Agriculture, University of Wisconsin, vice-president; Theodore Louis Jahn, Department of Zoology, University of Iowa, secretary-treasurer. The Executive Committee consists of Dwight L. Hopkins, University of Illinois, Navy Pier, Chicago; R. R. Kudo, University of Illinois, Urbana; John L. Mohr, University of Southern California, Los Angeles; Kenneth L. Osterud, University of Minnesota, Minneapolis; and Robert M. Stabler, Colorado College, Colorado Springs.

The object of the Society shall be "the association of workers in the field of protozoology for the presentation and discussion of new or important facts and problems in that science and for the adoption of such measures as shall tend to the advancement of protozoology." The possibility of publishing a journal was discussed and will be given further consideration in the future. Affiliation with the AAAS and with the American Institute of Biology will also be considered.

All protozoologists who wish to join the Society or who wish further information are invited to write to the secretary. New members who join before the next meeting will be considered as charter members of the Society and may participate in formulating the permanent constitution.

The Catholic Round Table of Science, at its annual meeting in Chicago, December 30, in conjunction with the AAAS meetings, elected Rev. John R. Cortelyou, assistant professor of zoology, DePaul University, Chicago, its new permanent secretary, to succeed Rev. Anselm Keefe, St. Norbert's College, West De Pere, Wisconsin, who has resigned after 19 years of service. Joseph E. Semrad, professor of zoology, DePaul University, was named head of a special committee to recommend new policies in line with organizational expansion. The Catholic Round Table of Science was organized in 1928 to stimulate scientific research in Catholic institutions in order to bring more Catholic workers into the fields of such research.

The Phycological Society of America held its first annual meeting, December 28 and 31, in conjunction with the AAAS meetings in Chicago. Sixteen papers were presented in a half-day program. At the business session, a constitution was adopted and the following officers elected for the coming year: William Randolph Taylor, president; L. H. Tiffany, vice-president; G. W. Prescott, secretary-treasurer (re-election); and I. F. Lewis, member of the Executive Committee.

Membership in the Society, which was organized in December of 1946 to promote the interests of phycology in this country and abroad, is open to individuals, institutions, and industrial concerns interested in phycology or phycological research. Membership now totals 152, 32 of whom reside in foreign countries. The Society publishes a *News Bulletin* which is issued quarterly.

The American Chemical Society has elected Emil Ott, director of research, Hercules Powder Company, Wilmington, Delaware, to the Board of Directors for a three-year term, succeeding Edward R. Weidlein, director, Mellon Institute for Industrial Research. Dr. Ott will act as regional director for the Third District, which embraces Pennsylvania, Ohio, and Delaware. Ernest H. Volwiler, executive vice-president, Abbott Laboratories, North Chicago, Illinois, was reelected for a four-year term as a director-at-large, and Charles A. Kraus, professor emeritus, Brown University, and a past president of the Society, was renamed regional director for the First District, consisting of New England and Canada.

The Botanical Society of Washington, at its December meeting, elected the following officers for 1948: president, Freeman Weiss; vice-president, Lee M. Hutchins; recording secretary, Katharina Bollenbacher; corresponding secretary, Anna E. Jenkins; treasurer, Wilbur D. McClellan; counselors, E. L. LeClerg and H. A. Borthwick; archivist, John A. Stevenson. Roland Bamford was nominated as representative to the Washington Academy of Sciences.

Deaths

Frederick B. Isely, 74, professor of biology at Trinity University, San Antonio, Texas, died December 30 after a brief illness.

Thaddeus Lincoln Bolton, 82, chairman, Department of Psychology, Temple University, for 22 years and professor emeritus since 1937, died in Temple University Hospital, Philadelphia, January 3.

C. O. Swanson, 78, formerly head, Department of Milling Industry, Kansas State College of Agriculture and Applied Science, Manhattan, died at his home in Manhattan, January 5, after a year's illness.

Max Pinner, 56, editor, *The American Review of Tuberculosis,* and formerly chief, Division of Pulmonary Diseases, Montefiore Hospital, New York, and Montefiore Sanitarium, Bedford Hills, New York, died at his home in Berkeley, California, January 7.

Vladimir Karapetoff, 72, professor emeritus of electrical engineering, Cornell University, died on January 11. Although blind since 1943, Dr. Karapetoff had been active as a consultant and lecturer.

Mellen W. Haskell, 84, professor emeritus of mathematics, University of California, Berkeley, died on January 15. Dr. Haskell joined the faculty there in 1890 and retired in 1933.

On the island of Bimini, a British possession lying about 50 miles east of Miami, Florida, the American Museum of Natural History is establishing the Lerner Marine Laboratory, which is to be under the direction of C. M. Breder, Jr., chairman of the Museum's Department of Fishes and Aquatic Biology. The new field base, now nearing completion, is named for its founder, Michael Lerner, naturalist and a member of the Museum's board of trustees, who has donated the Laboratory to the Museum and established a maintenance fund, in which others have participated, assuring year-round opportunity for many varied projects, the first of which will be the collection and identification of native fishes, marine invertebrates, and marine plants. The base provides a library-study, a large general laboratory, a small laboratory for microscopic work, a dark room for photographic and biological operations, and a large aquarium room for research on living organisms which is served by a nonmetallic sea-water pumping system. Also included are residences for the permanent staff and visiting scientists, storage space, a powerhouse with wind and gasoline generators, large and small boats equipped for observation and collection, diving helmets, concrete pools with running sea water, batteries of small aquaria, and a laboratory water table. Two large stockades have also been constructed in the sea for study of larger marine forms; in one of these, 122 feet long, sharks and barracuda are now under observation. According to A. E. Parr, director of the Museum, this new station will be the only one of its kind permanently operated by an institution such as the Museum.

D. Appleton-Century Company, Inc., and **F. S. Crofts & Co., Inc.,** have announced the merging of the two companies under the name of Appleton-Century-Crofts, Inc. Temporarily, the new company will maintain the offices heretofore occupied by the two former companies. President of the new company is W. Morgan Shuster; Frederick S. Crofts and Dana H. Ferrin will be directors and vice-president and executive vice-president, respectively; and Allen S. Wilbur will be vice-president and director of the Educational Book Department.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, announces the following wanted chemicals: 4,5-diamino-o-xylene; piperonylacetonitrile; 2-ketogluconic acid; succindialdehyde; d-threose; d-erythrose; monoperphthalic acid; heneicosane; eicosane; glucamine; 2-hexenal; tryptamine; germanium sulfide; germanium halides; 4-imidazole aldehyde; indole-3-aldehyde; decadiene-3,7; galactoflavin; pyridazone; canaline; agmatin; and galegin.

Make Plans for—

Symposium on the Diagnosis of Viral and Rickettsial Infections, January 29–30, New York Academy of Medicine, New York City.

American Physical Society, annual meeting, January 29–31, Columbia University, New York City.

American Society of Heating and Ventilating Engineers, February 2–5, New York City.

American Philosophical Society, midwinter meetings, February 6–7, (originally scheduled for February 13–14), 104 S. 5th Street, Philadelphia, Pennsylvania.

American Academy of Oral Pathology, 2nd annual meeting, February 8, Hotel Stevens, Chicago.

TECHNICAL PAPERS

Lipodieresis in Liver Tissue of Depancreatized Dogs

CESARE LOMBROSO and STEFANO BOCCHIOTTI

Pediatric Clinic G. Gaslini and *Department of Physiology, Medical University, Genoa, Italy*

The phenomenon of lipodieresis, first described in 1922 by Roger and Binet (*4*), consists of the disappearance of a part of the lipids stored in a tissue which has been kept for some time in aseptic autolysis. This observation has been the subject of various speculations. However, in this paper we shall only point out that subsequent extensive researches by various investigators have shown that lipodieresis occurs most markedly in liver tissue, that it is by no means quantitatively a constant phenomenon, and that it is apparently a reversible process (*2*, *3*).

While more extensive references to the literature will be given and discussed in a later paper, we summarize here some of the early findings of the above authors. When suspensions of finely chopped liver tissue of normal dogs are kept under aseptic conditions (with 1% sodium fluoride or thymol), it is observed that after 18–22 hrs there is a progressive decrease in the amount of its lipid content (as determined by the modified Kumagawa-Suto technique). This decrease, which may amount to 20% of the total lipid originally present, usually is maximal after 30 hrs or less. Subsequently it was shown that, if the suspensions are kept in the incubator under the same conditions for longer periods of time (*i.e.* 48–120 hrs), their fat content is progressively restored until the initial values of total lipid are reached again.

The present note deals with the effect of some pancreatic extracts upon the phenomenon of lipodieresis. It has been shown that, when suspensions of liver tissue taken from depancreatized dogs are used, the phenomenon of lipodieresis never occurs; that is, the lipid content of livers from depancreatized dogs always remains about constant during the whole period of autolysis (Table 1).

However, the addition of a small amount of pancreatic extract[1] to the same suspensions of liver tissue from depancreatized dogs restores the phenomenon of lipodieresis and the subsequent reappearance of fat. In other words, during 18–22 hrs of aseptic autolysis the lipid content decreases (as much as 30%) and then increases with time to its original value (Table 2). We have also examined the effect of that pancreatic extract having apparently lipotropic activity (so-called "lipocaic"), obtained as described by Dragstedt (*1*). It was found that this substance has an effect similar to, but quantitatively much less powerful than, that of the pancreatic extract first used.

[1] This extract was obtained simply by glycerine-water extraction and precipitation by calcium chloride and sodium phosphate. The amount of purified precipitate used was in the order of 1–2 mg/specimen of tissue.

TABLE 1*

LIPODIERESIS IN LIVER TISSUE OF DEPANCREATIZED DOGS

Dog No.	Liver lipids in weight %					
	Hours →	0	18	48	76	120
2	5-gm sample	12.7	12.3	12.7	12.8	12.2
4	" " "	26.5	26.01	26.2	26.11	26.4
5	" " "	19.21	19.13	19.09	19.14	19.22
6	" " "	23.15	23.04	23.07	23.14	23.17

TABLE 2*

LIPODIERESIS IN LIVER TISSUE OF DEPANCREATIZED DOGS WITH ADDITION OF SOME PANCREATIC EXTRACTS

Dog No.	Liver lipids in weight %					
	Hours →	0	18	48	76	120
1	5 gm liver + 5 mg lipocaic	12.72	12.11	12.14	12.10	12.63
2	5 gm liver + pancr. extract	26.50	18.21	23.43	23.90	26.72
2	5 gm. liver + 50 mg lipocaic	26.52	21.82	23.77	25.68	26.16
4	5 gm liver + pancr. extract	19.21	14.02	16.59	18.77	19.04
4	5 gm liver + 50 mg lipocaic	19.21	14.50	17.05	18.92	19.11
5	5 gm liver + pancr. extract	23.10	17.01	21.60	22.07	23.12
5	5 gm liver + 50 mg lipocaic	23.12	17.20	21.05	21.60	22.92

* Only a few of the data collected are reported in these tables.

Work is in progress now to test the effects of several other lipotropic substances, to determine the behavior of each lipid fraction separately, and to identify any water-soluble lipid material which might have been formed. Further research is warranted to determine the exact nature of the phenomenon of lipodieresis per se. While it is quite probable that this phenomenon may find its

explanation on a chemical-physical basis, its significance may be of interest also on the biological level, with regard to both fat transport and fat metabolism.

All that the above data appear to suggest at this point is that (1) liver suspensions of normal and of depancreatized dogs do not behave in the same manner as far as their lipid content is concerned when incubated for varying periods of time, (2) the addition of pancreatic extracts to the liver suspensions of depancreatized dogs seems to nullify this difference in behavior, and (3) the pancreatic extract called "lipocaic" appears to act, though less efficiently, in the same manner as the more easily obtainable extract first used.

References

1. Dragstedt, L. R. *Amer. J. Physiol.*, 1939, **127**, 755.
2. Lombroso U. *Arch. Antr. Crim.*, 1927, **47**, 467; Sunzeri, G. *Arch. Fisiol.*, 1934, **33**, 557.
3. Lombroso, U., and De Frisco, S. *Boll. Soc. Ital. Biol. Sp.*, 1927, **2**, 809; Zummo, C. *Atti Acc. Sc. Med. Palermo*, 1935, **6**; Lombroso, U., and De Frisco, S. *C. R. Soc. Biol.*, 1929, **101**, 449.
4. Roger, H., and Binet, L. *Presse Méd.*, 1922, **30**, 277; *C. R. Soc. Biol.*, 1922, **86**, 80.

Aspects of the Biologic Decay Periods of Sodium in Normal and Diseased Man[1]

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A knowledge of the duration of time for which a radioactive element is retained in the body has important significance physiologically, in safety considerations, and in dosage calculations in tracer studies and isotope radiation therapy. The biologic decay-life of sodium in man can be determined satisfactorily with the long half-life Na^{22} ($T_{\frac{1}{2}} = 3$ yrs) but not with Na^{24} ($T_{\frac{1}{2}} = 14.8$ hrs). During the course of experiments using Na^{22} in man and designed for other purposes, data were obtained which indicated the rates of elimination of sodium. Na^{22} with an activity such that 10,000,000–17,725,000 disintegrations occurred per minute was injected into each subject. A daily blood serum concentration of Na^{22} was determined for from 30 to 60 consecutive days. All samples of urine were collected separately and the Na^{22} excretion determined for each. The subjects consisted of 4 control subjects free from cardiovascular and renal disease, 6 subjects with chronic congestive heart failure (2 were slowly improving, 2 rapidly improving, and 2 becoming worse), and 2 subjects with chronic glomerular nephritis of the nephrotic type.

Since only the serum concentration of Na^{22} and the rate of urine excretion of the radioelement were measured, it was not possible to know the time required to excrete one-half of the injected Na^{22}, the biologic half-life period ($B_{\frac{1}{2}}$), *per se*. Therefore, it was necessary to introduce the following terms:

(1) $C_{\frac{1}{2}}$ = time required to reduce the serum concentration of Na^{22} to one-half the value obtained at any time after equilibrium of distribution has been reached.

(2) $U_{\frac{1}{2}}$ = time that would be required to eliminate one-half of the administered Na^{22} if it were being excreted only in the urine at the rate observed.

The results are briefly summarized in Table 1. It can be seen that with the exception of Subject No. 2 the $C_{\frac{1}{2}}$ periods were less than the $U_{\frac{1}{2}}$. This is to be expected because of the influence of other factors, such as other avenues of sodium excretion, shifts of sodium within the sodium compartments of the body, and variations in the volume of these compartments. The subjects with chronic congestive heart failure and those with chronic glomerular nephritis of the nephrotic type had $C_{\frac{1}{2}}$ and $U_{\frac{1}{2}}$ periods which were much longer than those of the controls (Table 1). Sodium and water diuresis in the subjects whose congestive heart failure rapidly improved resulted in a definite shortening of the $C_{\frac{1}{2}}$ and $U_{\frac{1}{2}}$ periods, the times be-

TABLE 1

Subject No.	$C_{\frac{1}{2}}$*	$U_{\frac{1}{2}}$†	Days of continuous observation	Weight change (lb)
		Control		
1	14	30	62	− 3.5
2	13	9	22	−14
3	12	42	45	−11
4	14	34	65	+ 2.3
Mean	13.3	28.8	48.5	− 6.6
		Congestive heart failure (Slowly improving)		
5	40	60	35	−18
6	42	72	46	− 7
Mean	41	66	40.5	−12.5
		Congestive heart failure (Rapidly improving)		
7	13	26	62	−29
8	28	33	58	−17
Mean	20.5	29.5	60	−23
		Congestive heart failure (Slowly becoming worse)		
9	24	72	68	+17
10	30	48	58	− 5.5
Mean	27	60	63	+ 5.8
		Chronic glomerular nephritis (Nephrotic type)		
11	58	660	45	+15
12	54	366	71	−86
Mean	56	513	58	−35.5

* Time in days required for the serum Na^{22} concentration to reach one-half at any time after equilibrium of distribution.

† Time in days required for one-half of the total Na^{22} injected to be eliminated by the urine.

[1] Aided by a grant from the Life Insurance Medical Research Fund, the War Contract No. W–49–007–MD–389, the Helis Institute for Medical Research, and the Mrs. E. J. Caire Fund for Research in Heart Disease.

coming even less than that for the normal subjects on high sodium intake. The $C_{\frac{1}{2}}$ periods in the control subjects were essentially the $B_{\frac{1}{2}}$ periods. This is less likely to be true for the abnormal subjects.

The $C_{\frac{1}{2}}$ and $U_{\frac{1}{2}}$ periods were influenced by measures which influenced sodium metabolism and excretion, such as sodium intake, desoxycorticosterone acetate, mercurial diuretics, water intake, and pitressin. Fig. 1 shows the influence of sodium intake on the $C_{\frac{1}{2}}$ and $U_{\frac{1}{2}}$ periods.

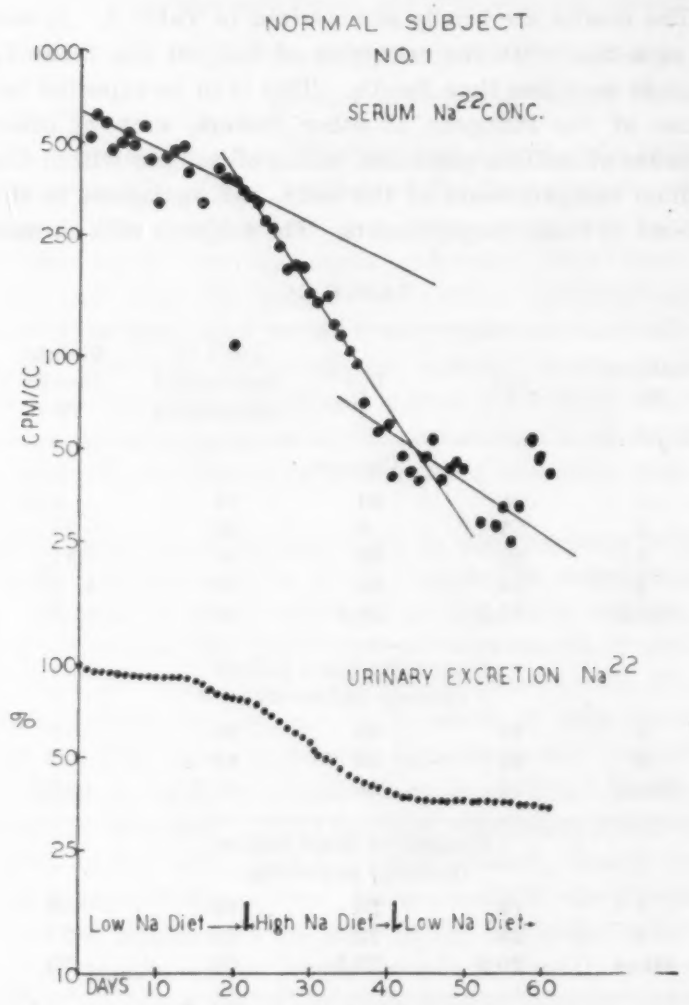

FIG. 1. Semilogarithmic graphs of changes in serum Na^{22} concentration (cpm/cc) and the rate of urinary excretion of Na^{22} (per cent of injected Na^{22} not eliminated in the urine) in Normal Subject No. 1.

The relationships of the changes in the rate of decrease in serum concentration and rate of urinary excretion to the changes in dietary sodium are shown. During the first 22 days while the subject was on a low Na diet (< 1.7 gm of NaCl/day) the rates were such that $C_{\frac{1}{2}}$ was 25 days and $U_{\frac{1}{2}}$ 100. During the next 19 days while the subject was on a high Na diet (13.7 gm of NaCl/day) $C_{\frac{1}{2}}$ was reduced to 8 days and $U_{\frac{1}{2}}$ to 19. During the last 19 days the subject was again on a low Na diet and antidiuretics. $C_{\frac{1}{2}}$ increased to 18 days and $U_{\frac{1}{2}}$ to 250.

These experiments have shown that the $B_{\frac{1}{2}}$ as well as the $C_{\frac{1}{2}}$ and $U_{\frac{1}{2}}$ for sodium are quite variable, being influenced not only by normal physiologic phenomena but particularly by disease and drugs. These variations must be taken into consideration when calculating the safety doses for radiosodium. $C_{\frac{1}{2}}$ and $U_{\frac{1}{2}}$ periods found for Na^{22} indicate the length of time required to turn over Na^{23} in man. The experiments will be published in detail elsewhere.

Isolation From Wild Bird Mites (*Liponyssus sylviarum*) of a Virus or Mixture of Viruses From Which St. Louis and Western Equine Encephalitis Viruses Have Been Obtained[1]

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In a previous communication by Reeves, Hammon, Furman, McClure, and Brookman (*1*) it was reported that in addition to three strains of Western equine encephalomyelitis virus isolated from mites, *Liponyssus sylviarum* (Canestrini and Fanzago),[2] found in the nest of a yellow-headed blackbird, another virus was isolated which was not as yet identified. Several months of laboratory work, including serial passages in several species of animals and extensive immunological tests, have led to the results summarized in this preliminary paper. When the studies are complete, they will be reported elsewhere in detail.

This agent, following isolation in mice and after several serial mouse passages, killed mice, guinea pigs, and chick embryos, but failed to kill guinea pigs which previously had been vaccinated with Western equine virus. It was not neutralized by hyperimmune Western equine serum or by St. Louis or Japanese B serum alone, yet a mixture of the three was effective in neutralizing the virus. A complement-fixing antigen prepared from the brains of mice infected with this virus reacted with specific antisera against Western equine, St. Louis, and Japanese B viruses, and antigens prepared from each of these three viruses in turn reacted with the sera from animals immunized against the mite virus. In cross-vaccination tests, however, there was no immunity in either direction in so far as Japanese B virus was concerned.

After 8 serial passages in mice the virus had only the immunological characteristics of St. Louis virus, and it would not kill guinea pigs. After 10 passages in chick embryos it had only the characteristics of a Western equine virus.

Two possibilities presented themselves: (1) that this was a simple mixture of two viruses or (2) that it was a stem virus maintained by mite-to-bird passage which could develop as either virus after passage in more selective hosts. The first possibility appeared more likely; but the second was challenging and not incredible, since these

[1] This investigation was carried out in collaboration with the Commission on Virus and Rickettsial Diseases, Army Epidemiological Board, Preventive Medicine Division, Office of the Surgeon General, U. S. Army, aided by a grant from the National Foundation for Infantile Paralysis, and under a contract with the California State Department of Public Health.

[2] These mites were collected and identified by entomologists and the ornithologist of the Neurotropic Virus Research Unit, including W. C. Reeves, D. P. Furman, B. Brookman, and H. E. McClure.

two viruses have been found so frequently in close association and appear to have the same vectors and vertebrate hosts. There is some further support for the latter possibility in the following results of two experiments. (1) Laboratory mixtures of known strains of these two encephalitis viruses, although not interfering completely in mice, are maintained with great difficulty through two passages. The Western equine virus is greatly inhibited, and attempts to recover it beyond the third passage have all failed. (2) Guinea pigs are killed promptly with signs typical of the Western encephalitis by a suspension of the brains of mice which die after an inoculation with 100 LD_{50} (third mouse passage) of the mite virus mixed and incubated with an equal volume of undiluted hyperimmune Western equine serum. The same suspension of mouse brain which killed normal guinea pigs failed to kill Western equine immune pigs. Thus, a high dilution of a third mouse passage of the mite agent, mixed with a great theoretical excess of Western equine immune serum, still maintained through passage a large amount of the equine-like component.

Until more convincing evidence can be presented that this agent represents a "new" virus, however, it appears to be more appropriate merely to report that a virus, or mixture of viruses, has been isolated from wild bird mites which, after serial passage in the brains of mice, may be identified as a strain of St. Louis encephalitis virus, and that a factor identifiable as the virus of Western equine encephalomyelitis is obtained after the agent is passed serially through chick embryos.

Reference

1. Reeves, W. C., Hammon, W. McD., Furman, D. P., McClure, H. E., and Brookman, B. *Science*, 1947, **105**, 411.

Periconia circinata, the Cause of Milo Disease

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The milo disease, which attacks the roots of susceptible milos and dwarfs and kills the plants, was first observed in Texas in 1924, and within a few years was found to occur also in other sorghum-growing states of the Southwest. For a time this disease threatened the growing of milo in certain areas of the Southwest. Resistant milos were developed, however, and now the severe losses formerly caused by the disease have been almost entirely eliminated.

For many years the exact cause of milo disease remained unsolved. The fact that susceptible milos grown in infested soil that had been sterilized by steam or chemicals remained free from the disease indicated that it was caused by a soil-borne organism. In 1937, Elliott, *et al.* (*1*) reported that the fungus *Pythium arrhenomanes* had been repeatedly isolated from the roots of susceptible milo plants grown in infested soil and affected with milo disease, and that this fungus was thought to be the causal organism. It had been previously found to be the cause of a common root rot of corn and sugarcane. It proved to be the cause also of a certain type of root rot in sorghum (*1*). It has never been demonstrated, however, that milo selections resistant to milo disease are resistant also to attack by *P. arrhenomanes*. The only logical conclusion, therefore, is that *P. arrhenomanes*, although able to attack the roots of sorghum, is not the fungus that causes milo disease.

Experiments have been in progress since 1942 at the Plant Industry Station, Beltsville, Maryland, to determine definitely the real cause of milo disease. Numerous isolations of fungi were made from the roots of susceptible milo plants grown in soil from infested fields and affected with typical milo disease. These fungi were grown on suitable media, and the cultures were used to inoculate separate portions of steam-sterilized soil. Selections of milo, resistant or susceptible to milo disease, were grown in these different lots of inoculated soil, and the growth of the plants was compared with the growth of these same selections in naturally infested soil and in steam-sterilized uninoculated soil. Some of these fungi reduced the percentage of emergence, caused damping-off, or produced other disease symptoms, but always with equal severity in selections resistant or susceptible to the milo disease. All isolates, except one, failed to produce results identical with those obtained in naturally infested soil. This one exception was a fungus that produced a mouse-gray mycelial growth on potato-dextrose agar. This growth later turned darker, due to the production of great numbers of large, black spores. The fungus was identified as *Periconia circinata* (Mang.) Sacc. When selections of milo susceptible or resistant to the milo disease were grown in the greenhouse in flats and beds of steam-sterilized soil inoculated with this fungus, the susceptible milo plants displayed symptoms identical with those shown by these same selections grown in naturally infested soil, while the resistant milos were not affected. Susceptible plants grown in lightly inoculated soil showed symptoms of milo disease similar to those seen in plants growing in lightly infested fields. Plants grown in heavily inoculated soil produced more severe symptoms similar to those seen in plants growing in infested fields that had been planted to milo for several years. Resistant and susceptible selections of each of 8 milo varieties yielded identical results when grown in flats of *Periconia*-inoculated soil and in flats of naturally infested soil. In each case the susceptible selections were killed, while the resistant selections were not affected. Typical milo disease was produced also in susceptible milo grown in an outdoor bed of steamed soil inoculated with *P. circinata*, while plants of resistant milo were not affected. Identical results were obtained in a similar adjacent bed containing naturally infested soil. In all these experiments in which susceptible milo was affected with typical milo disease when

grown in *Periconia*-inoculated soil or in naturally infested soil, the characteristic fungus, *P. circinata,* was readily recovered from the diseased roots.

In testing selections of milo for resistance to milo disease in the past, plant breeders were restricted in their studies to the use of soil naturally infested with the milo-disease pathogen. Such soils at times are rather heavily infested also with various other harmful fungi, whose effects on the plants under observation may be confusing. Now, however, with the use of steam-sterilized soil inoculated with the causal fungus, *Periconia circinata,* only, the resistance to milo disease will be more clearly indicated as effects of other fungi are eliminated. More complete details of these investigations will be published later.

Reference

1. Elliott, C. E., Melchers, L. E., Lefebvre, C. L., and Wagner, F. A. *J. agric. Res.*, 1937, **54**, 797–834.

Nature and Spatial Relationship of the Prosthetic Chemical Groups Required for Maximal Muscarinic Action

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Dale, in his Dixon Memorial Lecture (*5*), states: "To the fundamental pharmacological problems, why a particular type of chemical structure, or more mysteriously, several apparently unrelated types, should be associated with a specific action on particular types of reactive cells, we have made no nearer approach." With this in mind we have attempted to correlate pharmacological action with certain prosthetic groups[1] which appear as a common denominator in all potent parasympathomimetic drugs. Attempts to correlate structure-activity-relationships (SAR) of chemical series of pharmacological importance have hitherto mainly considered activity as variations in chain length of aliphatic series as drawn in two dimensions. Occasionally theories have been centered around the well-known ring systems of organic chemistry. Greater correlation and understanding of SAR might be obtained by depicting formulas in three dimensions, with bond distances calculated as accurately as our present knowledge will allow. Schueler (*16*) has applied this approach successfully in relating estrogenic activity to chemical constitution. Clark (*1, 2*), from his studies and those of other workers, has amassed almost incontrovertible evidence that pharmacological action in many instances depends on the activation of receptors on the cellular surface by specific chemical prosthetic groups on the drug molecule. A cellular surface action as a possible mode of action of the muscarinic drugs is assumed in this study.

From inspection of the numerous drugs having parasympathomimetic stimulant action it becomes apparent that all contain a ketone oxygen group adjacent to an ether oxygen linkage with a methyl substituted nitrogen at a distance of two saturated carbon atoms. Assuming that these molecules have three prosthetic groups, the interprosthetic distances may be calculated for many of the known potent stimulants. The size of the acetylcholine molecule (approximately 9 A × 3 A), when compared to the size of the cell surface (20 × 1 μ for vascular smooth muscle), is infinitely small. With atomic models where 1 A equals 1 cm, the smooth muscle cell, if drawn to the same scale, would measure 2,000 × 100 m, or roughly 1 mile long and a city block in diameter. Thus, the surface of the cell containing receptors may be considered as the segment of an arc with an infinite radius, and the interprosthetic distances, for practical purposes, may be regarded as linear distances and may be measured on Hirschfelder atomic models (*13*). The measured interprosthetic distances in acetylcholine are 7.0 A ketone oxygen to methyl, and 5.3 A ether oxygen to methyl (Fig. 1). Obviously, the interprosthetic distances for acetylcholine, methacholine, carbaminoylcholine, and urecholine are the same. Choline, which contains only two of the prosthetic group, has a parasympathomimetic stimulant action which is insignificant compared to that of acetylcholine. Compound 6 of Fig. 1, which has an acetal group, was

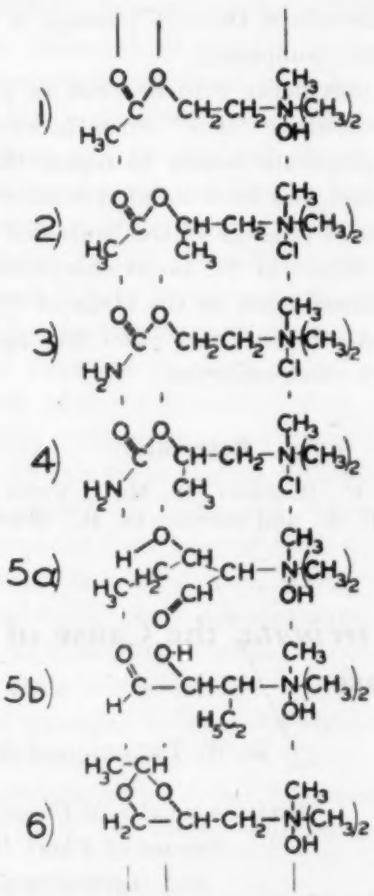

Fig. 1. Aliphatic parasympathetic stimulant drugs: (1) acetylcholine, (2) methacholine (Mecholyl), (3) carbaminoylcholine (Doryl), (4) urecholine, (5a) textbook formula for muscarine, (5b) Kögl's alternate formula for muscarine, (6) Bovet and Fourneau's acetal derivative.

[1] The term "prosthetic group" as used in this study refers to simpler chemical complexes such as methyl groups or oxygen atoms, whereas enzymologists utilize this term for larger chemical complexes.

recently studied by Bovet and Fourneau (*6*, *7*), who found it to be potent in a dose of 0.001 mg/kg. Apparently, if the interprosthetic distances are optimal, the receptors on the cell do not differentiate between ether, ketone, ester, or acetal oxygen atoms (see Compounds 5b and 6). Hence, the nomenclature "ether oxygen" and "ketone oxygen" has been adopted in this study. Thus, it becomes plausible that parasympathomimetic stimulant action depends on adjacent prosthetic oxygen atoms at a distance of approximately 5.0 A and 7.0 A, respectively, from one or more methyl groups attached to nitrogen (Table 1). The textbook (*8*) formula for muscarine (5a

TABLE 1

SUMMARY OF MEASUREMENTS ON ATOMIC MODELS

	Distances in Angstra	
	A*	B†
Acetylcholine	5.3	7.0
(A) Muscarine	5.0	5.5
(B) Muscarine	5.0	6.7
Bovet's acetal	5.0	7.0‡
Neostigmin	7.0	5.0
(Ortho) Neostigmin	3.2	3.0
(Para) Neostigmin	7.5	8.0
Arecoline	4.0	6.0
Pilocarpine	6.0	8.0
Physostigmine	7.0	8.5
Dibutoline	5.3	7.0
Compound E-3	5.3	7.0

* Distance from center of ether oxygen to center of methyl on nitrogen.

† Distance from center of ketone oxygen to center of methyl on nitrogen.

‡ Second acetal oxygen.

of Fig. 1) is probably in error, since Kögl and his coworkers (*11*, *12*), who first elucidated the alternate formulas in 1931, have been unable over a period of 11 years to choose between the two by chemical characterization methods or synthesis. Formula 5b is more likely from this analysis of the interprosthetic distances. A physical-chemical method of measurement, such as the determination of the electron diffraction pattern of muscarine, is needed and would be most helpful.

Inspection of the aromatic group of parasympathomimetic stimulants (Fig. 2) reveals in pilocarpine, arecoline, neostigmin, and physostigmine the three fundamental prosthetic groups at the same approximate interprosthetic distances that have been postulated for acetylcholine and its aliphatic homologues. The A and B distances (Table 1) are reversed in neostigmin, which may be a further indication that the effector cell does not differentiate between ether and ketone oxygen atoms. Neostigmin was formerly thought to possess stimulant properties solely by virtue of its ability to inactivate choline esterase, but comparisons of DFP and neostigmin in animals (*15*) and in patients with myasthenia gravis (*3*) show definitely that the latter also has a direct acetylcholine-like action on striated muscles. This would be in accord with the interprosthetic distances of its three prosthetic groups.

Quaternization of the amino nitrogen of the aliphatic series invariably results in greater pharmacological potency, which may be ascribed to the greater availability of methyl on nitrogen prosthetic groups. In the aromatic series quaternization increases the pharmacological potency only when the interprosthetic distance is optimal. Thus, Stedman (*17*) has shown that the ortho and para analogues of neostigmin lose potency when quaternized, while the meta analogue (neostigmin) becomes much more potent. The benzyl urethane analogues of neostigmin (*18*) further indicate the critical nature of the optimal

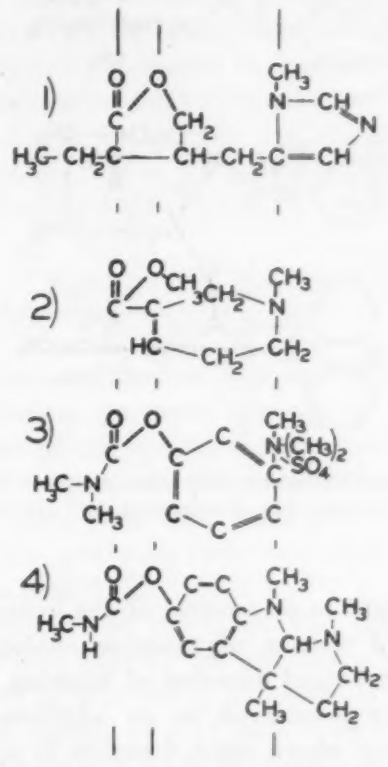

FIG. 2. Aromatic parasympathetic stimulant drugs: (1) pilocarpine, (2) arecoline, (3) neostigmin (prostigmin), (4) physostigmine.

interprosthetic distance, since in these derivatives the ortho analogue is the most potent and its activity is enhanced by quaternization while the slight activity of the meta derivative is decreased by quaternization. This may be due to the greater freedom of single methyl groups on nitrogen which makes the N to C bond distance 1.47 A available when the interprosthetic distance is too large or small. Thus, the interprosthetic distances of pilocarpine, arecoline, and physostigmine, while not optimal, may be compensated for by the fact that the methyl group is attached in each instance to a tertiary nitrogen and is freer to rotate toward or away from the oxygen prosthetic groups.

If the potent inhibitors of acetylcholine stimulation are now studied (Fig. 3), one finds again the three prosthetic groups postulated for acetylcholine action at the same or nearly the same interprosthetic distance. In these instances, however, the prosthetic groups are contained in the center ridge of a large umbrella-like molecule. This "umbrella-structure" is analogous to the blocking moieties of other blocking agents which have recently been synthesized (*i.e.* benadryl, which blocks histamine action (*19*) on various tissues, and dibenamine, which blocks most of the excitatory actions of epinephrin). The interprosthetic distances in dibutoline and

E-3 (*10*) are 7.0 A for the ketone oxygen to nitrogen methyl groups and 5.3 A for the ether oxygen to nitrogen methyl groups. Atropine interprosthetic distances cannot be calculated by the use of Hirschfelder models. A slight stimulant action should be expected from some of these agents before blocking occurs. Some evidence for this is found in the action of dibutoline on heart rate (*14*).

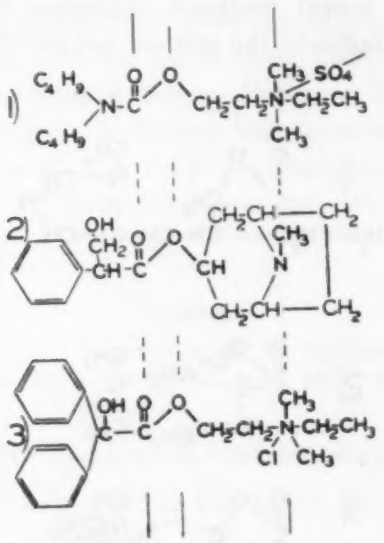

FIG. 3. Acetylcholine blocking agents: (1) dibutoline, (2) atropine, (3) Compound E-3 of Ing, Dawes, and Wajda.

Since modification or removal of the hydroxy group on the tropic acid portion of atropine analogues (*9*) decreases the degree and duration of blocking, the hydroxy group must be considered as an additional anchoring prosthetic group whose exact function is not at present clear. The simplest concept is that these blocking molecules adhere to the cell surface by means of the three or more prosthetic groups and by their continued adherence and difficult degradation prevent the smaller stimulant molecule from reaching the receptors on the cell. A second possibility which would account for the greater molar potency of atropine which blocks several mols of acetylcholine is that the umbrella-like atropine molecule may mechanically or electrostatically inactivate adjacent receptors on the cell surface so that these receptors are also unavailable for acetylcholine or other parasympathomimetic stimulants.

Other large molecules which contain only one or two of the acetylcholine prosthetic groups will show various degrees of blocking activity. Thus, methylene blue (*4*) has an atropine-like action when perfused through the isolated heart. Unlike atropine, however, methylene blue can be easily washed off the cell surfaces. The intracellular methylene blue is inactive, so that, after washing, the heart muscle, although stained blue, will again respond to acetylcholine. This phenomenon probably accounts for the mild atropine-like action of such antispasmodic drugs as Trasentin and Pavatrine, which contain only two prosthetic groups (double oxygen) and must be given in much larger doses than atropine.

Nicotinic action of the parasympathomimetic stimulants cannot be correlated at present with the prosthetic groups necessary for muscarinic action. Methyl on carbon, as in methacholine (2 of Fig. 1), apparently interferes with nicotinic action, whereas methyl on nitrogen is essential for nicotinic action (nicotine and α-lobeline).

The author realizes that distribution of active prosthetic groups, while perhaps responsible for major drug action, is strongly influenced by the associated molecular structure and the ease of degradation or detoxication of these moieties in the body. Thus, while one may be able to predict pharmacological action from prosthetic groupings, the usefulness of a new drug will depend on the pharmacological action of the associated molecular structure, which must always be determined by animal experimentation. The author further acknowledges that the present paper may contain several inaccuracies, due to the fact that interprosthetic distances have been calculated or measured from the meager data available on the interatomic bond distances of other organic compounds. The hypothesis is presented at this time with the hope that more accurate measurements may be made on these drugs by the physical-organic chemists so that pharmacologists can, in turn, define more accurately the prosthetic groups on molecules, interprosthetic distances, and the spatial relationship of the receptors on the surfaces of reacting cells. Since blocking molecules have a characteristic chemical configuration, this type of analysis may be extended to other pharmacological series (such as the barbiturates and analgesics), and the chemical nature of the hitherto unknown stimulant molecules may be closely predicted.

References

1. CLARK, A. J. *Mode of action of drugs on cells.* London: Arnold, 1933.
2. CLARK, A. J. *In* Heffter's *Handbuch der experimentellen Pharmacologie.* (Vol. 4.) Berlin: Julius Springer, 1934.
3. COMROE, J. H., JR., TODD, J., GAMMON, G. D., LEOPOLD, I. H., KOELLES, G. B., BODANSKY, O., and GILMAN, A. *Amer. J. med. Sci.*, 1946, **212**, 641–651.
4. COOK, R. P. *J. Physiol.*, 1926, **62**, 160.
5. DALE, H. *Proc. roy. Soc. Med.*, 1934–35, **28**, 319–332.
6. FOURNEAU, E., and BOVET, D. *C. R. Soc. Biol.*, 1944, **138**, 469.
7. FOURNEAU, E., BOVET, D., BOVET, F., and MONTEZIOR, G. *Bull. Soc. Chim. Biol.*, 1944, **26**, 134, 516.
8. GOODMAN, L. S., and GILMAN, A. *The pharmacological basis of therapeutics.* New York: Macmillan, 1941. P. 394.
9. GOODMAN, L. S., and GILMAN, A. *The pharmacological basis of therapeutics.* New York: Macmillan, 1941. P. 461.
10. ING, H. R., DAWES, G. S., and WAJDA, I. *J. Pharm. exp. Therap.*, 1945, **85**, 85.
11. KÖGL, F., DUISBERG, H., and ERXLEBEN, H. *Ann. Chem.*, 1931, **489**, 156–192.
12. KÖGL, F., VELDSTRA, H., and VAN DER LAAN, P. J. *Ann. Chem.*, 1942, **552**, 1–36.
13. PAULING, L., and BROCKWAY, L. D. *J. Amer. chem. Soc.*, 1937, **59**, 1223.
14. PETERSON, C. G., and PETERSON, D. R. *J. Pharm. exp. Therap.*, 1945, **84**, 236.
15. RIKER, W. F., JR., and WESCOE, W. C. *J. Pharm. exp. Therap.*, 1946, **88**, 58.
16. SCHUELER, F. W. *Science*, 1946, **103**, 221–223.
17. STEDMAN, E. *Biochem. J.*, 1926, **20**, 719–734.
18. STEDMAN, E. *Biochem. J.*, 1929, **23**, 2–24.
19. WELLS, J. A., MORRIS, H. C., BULL, H. B., and DRAGSTEDT, C. A. *J. Pharm. exp. Therap.*, 1945, **85**, 122.

IN THE LABORATORY

The Specific Heat of Human Blood [1]

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Although the specific heat of blood was taken to be 0.90 by Stewart (*3*), no detailed report on its determination is available. In studying digital blood flows and pressures by the calorimetric method (*1*), with a view toward determining the effect of viscosity on vascular resistance in the living human subject, it was necessary to be sure that the specific heat of blood did not vary with erythrocyte concentrations such as are found in anemia and polycythemia.

A wide-mouthed Dewar flask, holding approximately 600 cc of fluid, was employed as a calorimeter. Into this flask, through a large cork stopper, were thrust a heating blade, a perpendicular hand stirrer, and a Beckman thermometer set at approximately 30–35° C. The heating device was connected in series to an ammeter and through an auto-transformer to an outlet of ordinary alternating current (110 v). The auto-transformer was regulated to deliver 0.5 amp constantly.

To determine the hydrothermic equivalent of the calorimeter, 595 gm of distilled water was placed in it, the current was turned on and adjusted to 0.5 amp, with a constant rate of stirring at approximately 150 strokes/min, and the rise in temperature per minute then determined. When a constant reading was obtained, the current was turned off and the fall in temperature per minute with the same rate of stirring was determined. In the formula, the rise and fall in temperature per minute were added, the heat of stirring being in this manner canceled out. Following the determination for water, a comparable volume of 1–25 molar solution of potassium carbonate with a known specific heat (0.76) was introduced into the calorimeter. With the current again adjusted to 0.5 amp, both the rise in temperature per minute and the fall in temperature after the current was turned off were determined. If x = the hydrothermic equivalent of the calorimeter, a = the rise in temperature per minute of water with the current on, b = the fall in temperature per minute of water with the current off, W_1 = the weight of water in grams, and K_1 = the specific heat of water at 30–35° C, (0.997), the number of calories delivered per minute would then be $(a+b)(K_1W_1+K_1x)$. Similarly, for the solution of known specific heat, if x = the hydrothermic equivalent of the calorimeter, c = the rise in temperature per minute for the solution with the current on, d = the fall in temperature per minute for the solution with the current off, K_2 = the specific heat of the solution, and W_2 = the weight in grams of the tested solution, then $(c+d)(K_2W_2+K_1x)$ represents the number of calories elaborated per minute in the solution.

Since the amount of heat elaborated for the water and the known solution is the same per minute, because the amperage in each case is 0.5 continuously, then $(a+b)(K_1W_1+K_1x)=(c+d)(K_2W_2+K_1x)$. Solving this equation,

$$x=\frac{K_2W_2(c+d)-K_1W_1(a+b)}{K_1(a+b-c-d)}.$$

The hydrothermic equivalent was thus determined to be 108. To calculate the error inherent in the method, 5 determinations of the specific heat of 1–25 molar potassium carbonate were made, using 108 as the hydrothermic equivalent. These were 0.74, 0.75, 0.76, 0.76, and 0.75, respectively, the maximum error being 3% and the average error less than 1%.

The specific heat of the blood was then determined. Clotting was prevented by the addition of 10 cc of 30% sodium citrate to each 600 cc of blood. In order to differentiate the specific heat of cells from that of plasma, one determination was made of plasma alone. This was done in the following manner: The number of calories elaborated by 0.5 amp was again determined for 595 gm of water. A comparable volume of plasma was then substituted for the water, and the total number of calories elaborated by the identical amperage determined. If K_3 = the specific heat of the plasma, e = the rise in temperature per minute in the calorimeter containing the plasma, with the current at 0.5 amp, f = the fall in temperature per minute after the current was turned off, W_3 = the weight of the plasma in grams, and W_c = the hydrothermic equivalent of the calorimeter (determined above), then $(e+f)(K_3W_3+K_1W_c)$ is the number of calories elaborated per minute in the sample of plasma. Since the calories elaborated in the water were again the same as those elaborated in the plasma, then $(a+b)(K_1W_1+K_1W_c)=(e+f)(K_3W_3+K_1W_c)$. Solving,

$$K_3=\frac{K_1W_1(a+b)+K_1W_c(a+b-e-f)}{W_3(e+f)}.$$

The specific heat of normal blood plasma was found to be 0.94.

A second determination was made using a comparable volume of blood from which most of the plasma had been separated. The specific heat of this mixture of cells and plasma was determined in the same way as for plasma. The hematocrit was also determined in the standard manner, in a Wintrobe tube. The volumetric hematocrit was

[1] From the Service of Dr. George Baehr, The Mount Sinai Hospital, New York. The work was aided by grants from the Dazian Foundation and the American Medical Association Research Fund. The technical assistance of Miss E. Di Pasquale, and the cooperation of Drs. N. Rosenthal, F. Bassen, and S. Feitelberg in making the apparatus and blood available for this work, are gratefully acknowledged.

corrected for "trapped" plasma (4.5% by volume of cells) (*2*) and then converted into gravimetric percentage as follows: The specific gravity of plasma is 1.026 (average) and of whole blood containing 5,000,000 erythrocytes, 1.060 (*2*). The hematocrit of such blood is 43.2 by volume (*4*), corrected for "trapped" plasma to 41.3. If x = the specific gravity of cells, then $41.3\,x + (58.7)(1.026) = (100)(1.060)$. Solving, $x = 1.108$. If the volumetric hematocrit is h_1, and the gravimetric h_2, then

$$h_2 = 100\frac{1.108\,h_1}{1.108\,h_1 + 1.026(100 - h_1)}.$$

Solving,

$$h_2 = \frac{110.8\,h_1}{.082\,h_1 + 102.6}.$$

In calculating the specific heat of the cells, if x = the specific heat of the cells, K_3 = the determined specific heat of plasma, K_4 = the determined specific heat of the mixture of cells and plasma, and h_2 = the gravimetric hematocrit (corrected for "trapped" plasma) of this mixture in per cent, then $100\,K_4 = K_3(100 - h_2) + h_2x$.
Solving,

$$x = \frac{100\,(K_4 - K_3) + h_2K_3}{h_2}.$$

By this method the specific heat of cells, which may be redesignated K_5, was determined to be 0.77.

To test the accuracy of the method, the specific heats of several random mixtures of cells and plasma were calculated. If x = the specific heat of the mixture, and h_2 = the gravimetric hematocrit (corrected for "trapped" plasma) of that mixture, then $100\,x = (h_2 - 100)\,K_3 + h_2K_5$. The specific heat of this mixture was then measured directly and checked against the calculation. The results of four such calculations were as follows:

Sample No.	1	2	3	4
Hematocrit volumetric, uncorrected	32.4	42.4	41.6	30.0
Specific heat, calculated	0.89	0.87	0.87	0.89
Specific heat, actual	0.89	0.86	0.86	0.88

The small discrepancies between calculated and actual specific heats may be attributable to the error inherent in the method, and perhaps in part to minor variations in the hemoglobin content of the cells and in the percentage of solids, especially proteins, in the plasma. The correlation is, nevertheless, good, and the specific heat of any mixture of cells and plasma can be calculated from the hematocrit.

The low specific heat of cells in comparison with plasma is probably due to their greater concentration of solids, especially iron.

References

1. MENDLOWITZ, M. *J. clin. Invest.*, 1942, **21**, 539.
2. PHILLIPS, R. A., VAN SLYKE, D. D., DOLE, V. P., EMERSON, K., JR., HAMILTON, P. B., and ARCHIBALD, R. M. *U. S. Navy Bumed News Letter*, 1943, **1** (9), 1.
3. STEWART, G. N. *Harvey Lectures*, 1912–13, 86.
4. WINTROBE, M. M. *Clinical hematology*. Philadelphia: Lea & Febiger, 1944.

Qualitative Reaction for 2,4-Dichlorophenoxyacetic Acid[1]

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There has arisen a need for a chemical method of identification of trace amounts of 2,4-D. Various bioassays employing plants have been proposed (*5*), as have methods of quantitative determination of the material, ranging from several gamma/ml to a gram and up (*1, 3, 4*). Bandurski (*1*) has employed a spectrophotometric method for the determination. However, quantitative methods of analysis are not always suitable for qualitative identification of a chemical.

To date, no satisfactory color derivative of 2,4-D has been developed that would serve as a quantitative means of identification (*5*). Various derivatives have been tried, including the nitro derivatives and their reduction analogs (*3*), but these have not proven satisfactory.

Certain characteristic salts (*3*) are formed by 2,4-D, the most distinctive of which is the uranyl salt. This salt is bi-axial in one plane with distinctive markings radiating pinnately from the axes. However, since the range of this method is 200–400 γ of material/ml, it is not capable of detecting really micro amounts.

Various means of identification have been tried in this laboratory with varying degrees of success. A halogen-substituted aromatic compound, if negatively substituted in the ortho or para position, will react with ammoniacal alcohol to form an amino derivative. The sodium-1-2-naphthoquinone-4-sulfonate will then detect the amino group (*2*). This reaction employing sodium-1-2-naphthoquinone-4-sulfonate was found to be reasonably effective in detecting 2,4-D, but lacked sensitivity and ease of application.

It was noted that when acid was warmed gently in concentrated sulfuric acid with 1,8-dihydroxy naphthalene 3,6-disulfonic acid (chromotropic acid), a characteristic wine-purple color resulted. As little as 0.05 γ of 2,4-D/ml could be detected by this test. As far as we are aware, this reaction has never been reported in the literature.

The procedure consists of introducing 2,4-D into a test tube and bringing it down to dryness. It has been found that benzene is the most suitable material for extraction of the 2,4-D for this reaction. Certain other solvents, notably alcohol, interfere slightly with the results. After bringing the material down to dryness, a few crystals of the chromotropic acid are introduced on the end of a micro spatula, 2 ml of concentrated sul-

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furic acid added, and the material heated in a glycerine bath at 150° C for 1½–2 min. If the material is overheated, a charring occurs which interferes with the results of the test. The color develops quite rapidly while heating, going through the stage of pink to purple to a very deep wine-purple color.

Attempts were made to employ a standard liquid reagent by dissolving the chromotropic acid in concentrated sulfuric acid, but this proved unsatisfactory since the reagent (chromotropic acid) decomposed upon standing with the sulfuric acid. An excess of chromotropic acid is needed for maximum color development.

Because of the extreme sensitivity of the reaction, it is of the utmost importance that the glassware used be absolutely free of the 2,4-D. The author has encountered difficulty in running blank reactions with test tubes that had been washed thoroughly with soap and hot water and put through rinses of clean water because of the trace of 2,4-D left in the reaction vessel.

TABLE 1

Acid	H_2SO_4	+ Chromotropic acid
Acetic	No color	Purple
Chloroacetic	" "	Weak pink
β-Brompropionic	Brown	Brown
Butyric	Pinkish-brown	Brown-reddish-pink cast
Maleic	No color	Brownish-yellow
Malic	" "	Yellow
Tartaric	Yellow	Yellow changing to bright green, finally to brown
Lactic	"	Yellow
Oxalic	No color	Light pink
Dinheptylacetic	Brown	Brown
Phenylacetic	Yellow	Yellow
2,4-Dichlorophenyl-acetic	No color	Pink
o-Chlorophenoxy-acetic	Pink	Wine-purple
p-Chlorophenoxy-acetic	No color	Reddish-pink
2,4-Dichlorophenoxy-acetic	" "	Wine-purple
2,4-Dibromophenoxy-acetic	" "	" "
Benzoic	" "	Brown
2,4-Dichlorobenzoic	Pink	Dark pink
4-Chloro-2-methyl-phenoxyacetic	No color	Brownish cast
2,4,5-Trichloro-phenoxyacetic	" "	Wine-purple
Pentachlorophenoxy-acetic	" "	" "
Indole acetic	Light pink	Light pink
Naphthalene acetic	No color	Pinkish-brown
Salicylic	Brown	Brown
Stearic acid	Yellow	Yellow
Phenylethyl acetate	"	"

This test is not entirely specific for the 2,4-D, as other organic acids will also give this color. However, it is sufficiently characteristic to make its use feasible in the identification of the 2,4-D, even when it is extracted from plant material.

Table 1 gives the characteristic reaction of a number of organic acids and one ester with both sulfuric acid and the sulfuric acid-chromotropic acid mixture.

It is interesting to note that, in the aromatic acids, only the halogen derivatives of these acids react to give a characteristic color. An example of this is the phenylacetic acid and the 2,4-dichlorophenylacetic acid. Some difference is noted also in the position of substitution. For example, the *o*-chlorophenoxyacetic acid gives a much deeper color with the reagent than the *p*-chlorophenoxyacetic acid.

While the mechanism of this reaction has not been determined—and so far we have used it only as a qualitative method—there does appear to be a possibility that the reaction could be put on a quantitative basis. We have found that, by employing varying quantities of 2,4-D, a more intense color results as the quantity of 2,4-D is increased. However, the technique is not sufficiently refined to enable one to determine the differences consistently between runs, and occasionally the relationship does not appear to be linear in the same run. This is probably due to the failure of the technique employed in carrying out the reaction.

References

1. Bandurski, R. S. *Bot. Gaz.*, 1947, **108**, 446.
2. Fiegl, F. *Manual of spot tests.* New York: Academic Press, 1943.
3. Freed, V. H. Unpublished data.
4. Rooney, H. A. *Ann. Chem.*, 1947, **19**, 475–476.
5. Swanson, C. P. *Bot. Gaz.*, 1946, **107**, 507–509.
6. Umhoefer, R. M. *Ind. eng. Chem.* (Anal. ed.), 1943, **15**, 361–416.

Proposed Method for Measuring the Movement of Soluble Fertilizer Salts in the Soil

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During the past 17 years the author has had an opportunity to use various types of lysimeters in studying the movement of soluble salts in the soil during the growing season. One of the uses made of the data collected from these lysimeters was to advise growers concerning the extent of leaching of plant nutrients from the soil. The installation of lysimeters and the collection and analyses of the leaching therefrom requires rather elaborate installation costs and detailed procedures.

In the past few years a simple system of measuring the movement of soluble salts in the soil has been under study and has been very valuable from the standpoint of recommending fertilization practices for different soil types. The system consists of sinking 10′ × 10′ frames of 12″ boards about 6″ in the soil. To the soil in these frames a definite amount of chloride ion is added by dissolving it in a given amount of water and sprinkling it uniformly over the soil. As many different conditions as desired can be established, and frames can be placed on as many different types of soil as conditions warrant.

The installation in this study consists of frames established on three different soil types: (1) Evesboro sand, (2) Woodstown sandy loam, and (3) Sassafras loam (clay subsoil). Part of the frames are kept clean cultivated and the others are in sod. After thoroughly sampling the soil, 500 gm of potassium chloride is added at the beginning of the growing season. Soil samples are taken periodically, usually at monthly intervals, from the 0–9″ and 9–18″ depths. The samples are carefully screened and 50 gm placed inside of a collodion bag in an extraction flask (Fig. 1) with 50 ml of water on the inside and

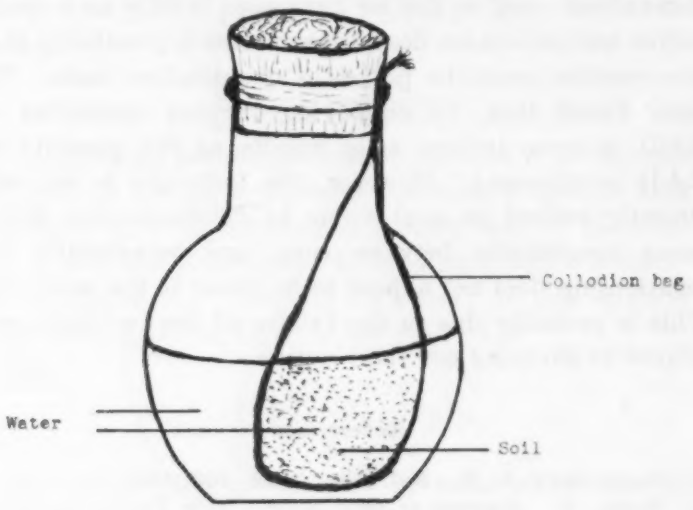


FIG. 1. Dialysis through collodion bag to insure clear extract.

50 ml on the outside of the bag. After allowing the chlorides to come to an equilibrium (usually a period of 24 hr), a portion of the clear solution on the outside of the bag is titrated with silver nitrate using potassium chromate as an indicator.

The correlation of the movement of the chloride ion with rainfall is shown in Fig. 2.

In 1946 and 1947 the percentage of the chlorides that have moved through 18 inches of the soil has been calculated periodically, and the growers of this section have been advised of their loss. In other words, after a period of heavy rainfall the samples can be drawn, the chlorides determined, and, from the previous analyses, the amount of soluble chlorides lost can be calculated. Therefore, interpolations in terms of soluble plant nutrients such as nitrates and accompanying cations can be made. This information has proved very valuable to the growers from the standpoint of furnishing them additional knowledge regarding the amount of fertilizer to use in sidedressing operations. From the standpoint of final yields, the system has been extremely valuable, and for this reason this preliminary information is being presented.

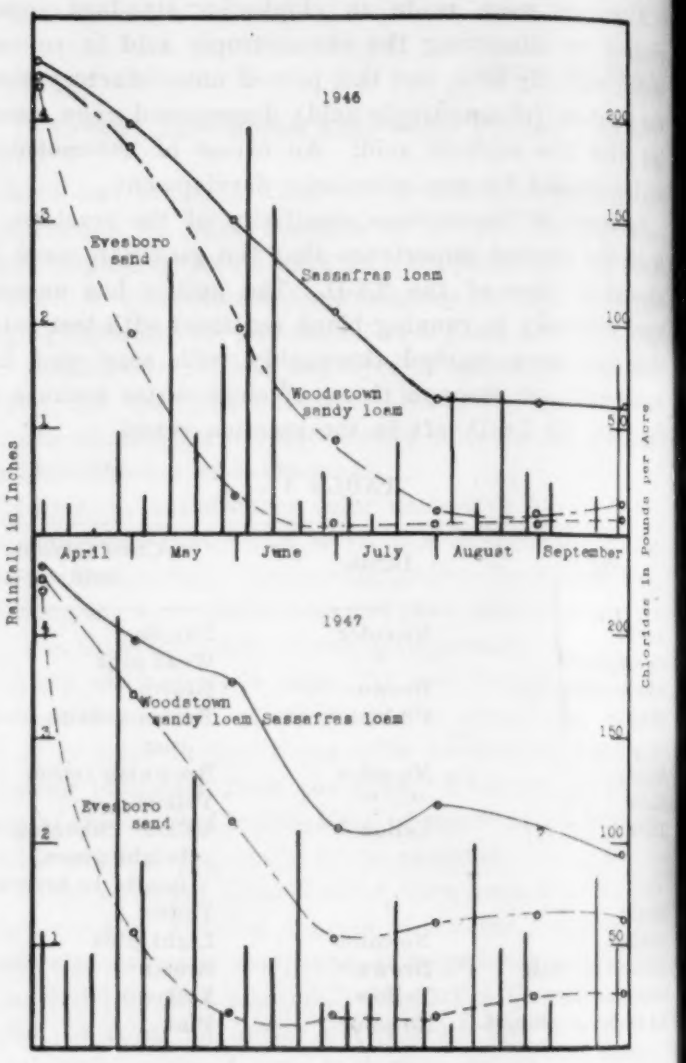
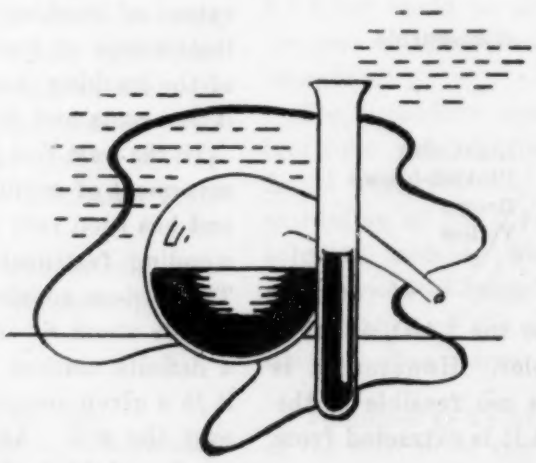


FIG. 2. Leaching of chlorides through 18″ of soil.

It is believed that after accumulation of these data for a number of years the loss can be calculated from the rainfall records without actual analyses.